Lincoln Electrodes

SB-1352

LINCOLN Weldirectory

for

STAINLESS STEELS
NON-FERROUS METALS
CAST IRON
and
MANUAL HARDSURFACING

THE LINCOLN ELECTRIC COMPANY
The World's Largest Manufacturer of Arc Welding Equipment
CLEVELAND 17, OHIO

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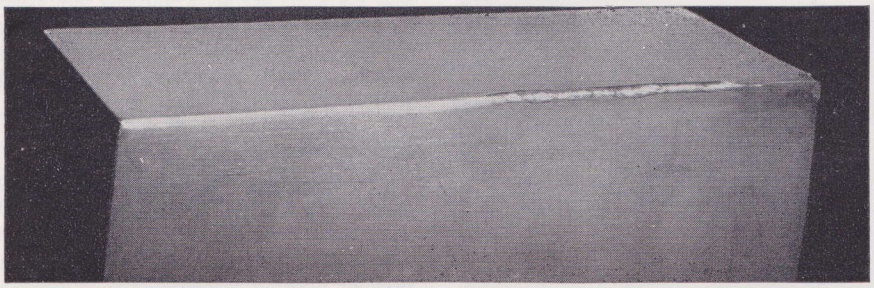
Coating—Light Green
Code—(E) Yellow
(G) Black

Class—**E-347-15**
Coating— 9″ lengths—dark gray
14″ lengths—light green
Code—(E) Yellow
(S) Blue
(G) Black



Corner weld in 18-8 stainless steel welded with "Stainweld A5-Cb." Left-hand portion is ground. Note smoothness.

APPLICATION

"Stainweld A5" and "Stainweld A5-Cb" are lime type shielded arc electrodes for welding stainless steels of 18-8 and 19-9 chromium — nickel variety. Both types are suitable for all position welding.

"Stainweld A5-Cb" is columbium stabilized; "Stainweld A5" is not.

Either A5 or A5-Cb may be used for welding unstabilized AISI stainless steel types 301, 302, 304 and 308, and may also be used for strength welds on manganese steels.

The stabilized stainless steels AISI #321 & 347 and ELC (Extra Low Carbon Stainless) should be welded with A5-Cb only.

PROPERTIES OF DEPOSITED METAL

Produces dense welds with corrosion resistance equal to or greater than that of parent metal. Weld can be ground and polished with perfect results.

"STAINWELD A5-Cb":

Average chemical analysis of all-weld metal deposit. "Stainweld A5-Cb", .065% carbon, 19.7% chrome, 9.5% nickel, .80% columbium.

AS WELDED:

Tensile strength—90,000 to 100,000 lbs. per sq. in.

Elongation in 2 inches—30% to 45%

"STAINWELD A5":

Average chemical analysis of all-weld metal deposit. "Stainweld A5", .060% carbon, 19.7% chrome, 9.5% nickel.

AS WELDED:

Tensile strength 85,000 to 95,000 lbs. per sq. in.

Elongation in 2 inches—35% to 50%.

PROCEDURE

POLARITY—Electrode positive, work negative. When welding thin sheets at low currents (below 30 amps) use electrode negative.

Proceed as with mild steel, only take into account higher electrical resistance, lower thermal conductivity and higher thermal expansion (about 50% greater than mild steel). Prepare and fit work carefully and clean joint of all foreign material.

Hold as short an arc as possible without choking or sticking. For best results use only enough current to obtain a free-flowing arc and proper fusion to base metal. Avoid excessive weaving. A number of straight beads are preferable.

When more than one bead is used, thoroughly clean the slag from the preceding bead. Thin sheets should be clamped against a copper or steel backing to maintain alignment of the seam and prevent burning through.

WELDING VERTICAL AND OVERHEAD—Use smaller sizes (up to 5/32″) with amperage in lower portion of range. In overhead welding, build the weld with several normal beads without weaving.

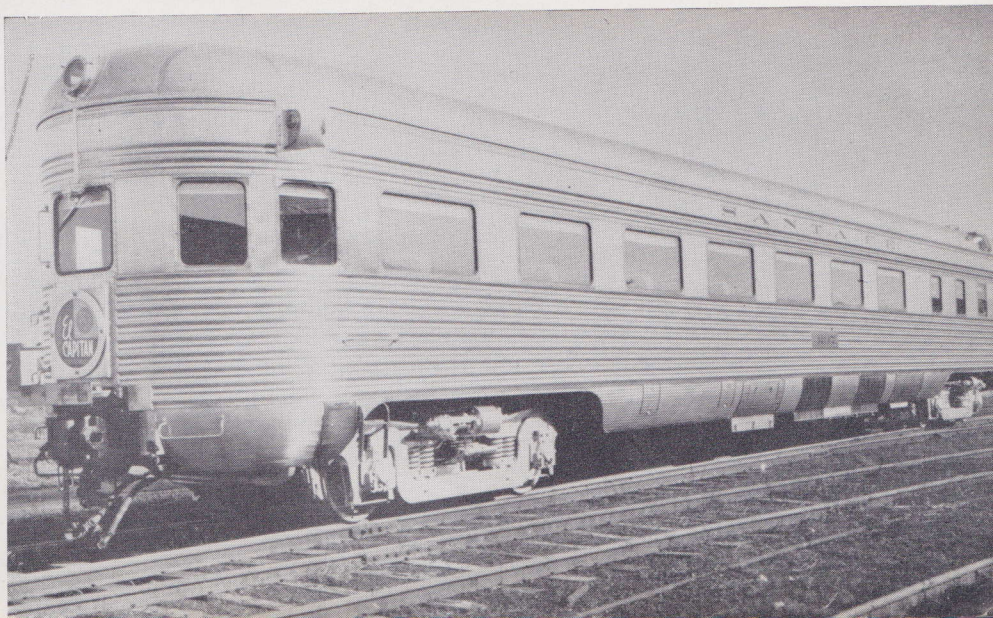
FLAT, VERTICAL & OVERHEAD		
A5-Cb Sizes	A5 Sizes	Amperage Range
1/16″x 9″	1/16″x 9″	10– 40
5/64″x 9″	5/64″x 9″	20– 55
3/32″x 9″	3/32″x 9″	30– 70
1/8″ x14″	1/8″ x14″	50–100
5/32″x14″	5/32″x14″	75–130
3/16″x14″	3/16″x14″	95–165
1/4″ x14″	1/4″ x14″	150–225

Standard containers for 14″ length—50 lbs.; for 9″ length—25 lbs.

Stainless steel sheathed car for streamliner train. "Stainweld A5-Cb" is used extensively in the construction of these modern, light-weight cars. Courtesy Pullman-Standard Car Mfg. Co.

TYPICAL APPLICATIONS

Dairy equipment
Bar room fixtures
18-8 tanks, piping, etc.
Steam valve fittings
Stainless clad tanks
Food plant equipment
Packing house meat racks
Kitchen fixtures
Acid container linings
Stainless steel trains
Display equipment
Bi-metal slabs
Chemical equipment
Hard-surfacing base
Manganese steel parts for high strength
High carbon bumpers
Dissimilar metals
High carbon to mild steel
Die steel bond



Class—**E-308-16**
Coating—Light Gray
Code—(E) Yellow
(G) Yellow

Class—**E-347-16**
Coating—Light Gray
Code—(E) Yellow
(S) Blue
(G) Yellow

STAINWELD A7
STAINWELD A7-Cb

Titania Coated AC/DC Electrodes for Welding 18-8 Stainless and Surfacing

APPLICATION

"Stainweld A7" and "Stainweld A7-Cb" are titania type shielded arc electrodes for welding stainless steels of 18-8 and 19-9 chromium-nickel variety.

"Stainweld A7-Cb" is columbium stabilized; "Stainweld A7" is not.

Either A7 or A7-Cb may be used for welding AISI unstabilized stainless steel types 301, 302, 304 and 308, and may also be used for strength welds on manganese steels.

The stabilized steels AISI #321 & 347 and ELC (Extra Low Carbon Stainless) should be welded with A7-Cb only.

PROPERTIES OF DEPOSITED METAL

Produces dense welds with corrosion resistance equal to or greater than that of parent metal.

Welds can be ground and polished with perfect results.

"STAINWELD A7-Cb":

Average chemical analysis of "Stainweld A7-Cb": .065% carbon, 19.7% chrome, 9.5% nickel, .80% columbium.

AS WELDED:

Tensile strength—90,000 to 100,000 lbs. per sq. inch.

Elongation in 2 inches—35% to 50%.

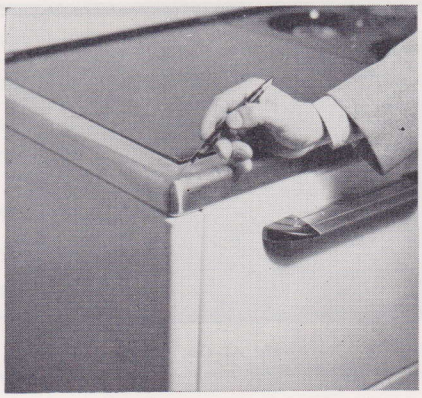
"STAINWELD A7":

Average chemical analysis of "Stainweld A7" all weld metal deposit: .06% carbon, 19.7% chrome, 9.5% nickel, no columbium.

AS WELDED:

Tensile strength—85,000 to 95,000 lbs. per sq. in.

Elongation in 2 inches—35% to 50%.



Corner joint in stainless steel edge band of gas range welded with "Stainweld A7." Grinding and buffing make weld indistinguishable.

PROCEDURE

POLARITY—D.C. (electrode positive). Also suitable for use with industrial type AC transformers.

Proceed as with mild steel, only take into account higher electrical resistance, lower thermal conductivity and higher thermal expansion (about 50% greater than mild steel). Prepare and fit work carefully and clean joint of all foreign material.

Hold as short an arc as possible without choking or sticking. For best results use only enough current to obtain a free-flowing arc and proper fusion to base metal. Avoid excessive weaving. A number of straight beads are preferable.

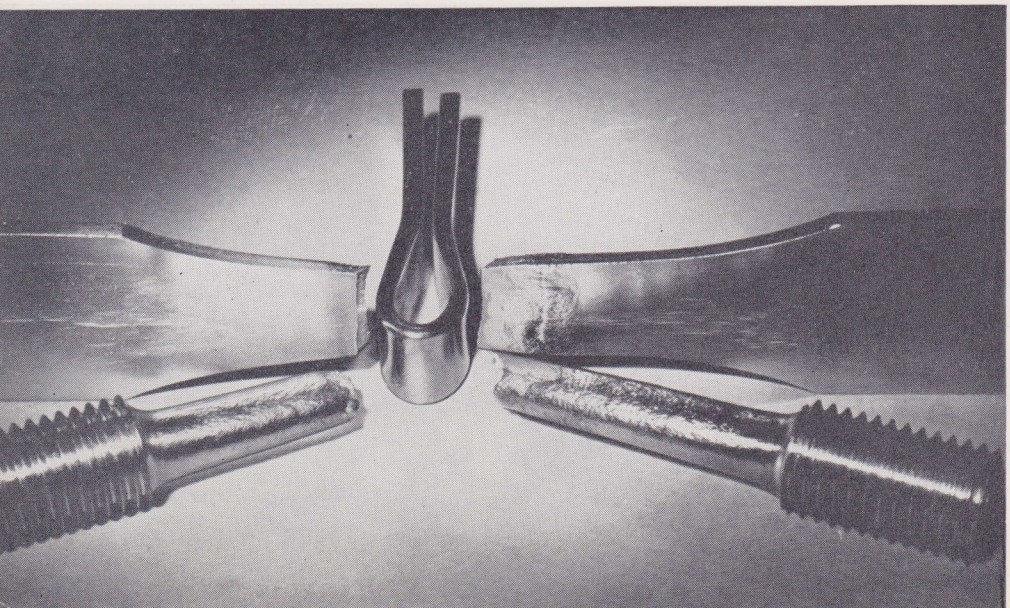
When more than one bead is used, thoroughly clean the slag from the preceding bead. Thin sheets should be clamped against a copper or steel backing to maintain alignment of the seam and prevent burning through.

WELDING VERTICAL AND OVERHEAD—Use smaller sizes (up to 5/32") with amperage in lower portion of range. In overhead welding, build the weld with several normal beads without weaving.

FLAT, VERTICAL & OVERHEAD		
A7-Cb Sizes	A7 Sizes	Amperage Range
.....	5/64"x 9"	20– 45
3/32"x 9"	3/32"x 9"	30– 60
1/8" x14"	1/8" x14"	55– 95
5/32"x14"	5/32"x14"	80–135
3/16"x14"	3/16"x14"	115–185
.....	1/4" x14"	200–300

Standard containers for 14" length—50 lbs.; for 9" length—25 lbs.

Specimens of 18-8 stainless steel welded with "Stainweld A7." As welded: weld metal tensile strength 88,000 lbs./sq. in.; free bend elongation 53% in outer fibres; tensile pull sample failed in plate at 88,600 lbs. per sq. inch.



TYPICAL APPLICATIONS

Milk condensers	Aircraft exhausts
Coolers	Split dipper lips
Milk separators	Broken dies
Kitchen equipment	Manganese to manganese
Valve seats	Auto bumpers
Chemical tanks	Alloy castings
Heat exchangers	Forging dies
Storage tanks	Alnico castings
Cheese vats	Dredge drill rods
Cracking tower lines	

STAINWELD B-Cb

Lime Coated D. C. Electrodes for Welding 25-12 Stainless

Class—E-309-Cb-15
Coating—Light Green
Code—(E) Black
(S) Blue
(G) Black

APPLICATION

"Stainweld B-Cb" is a shielded arc electrode for welding stainless steels of the 25% chromium, 12% nickel variety in any position. These are the stainless steels AISI type 309 and 309S.

"Stainweld B-Cb" is recommended for welding stainless steels of 18-8 and 19-9 chromium-nickel variety to mild steel and steels of lower alloy content.

"Stainweld B-Cb" may also be used for high temperature applications when resistance to oxidation is necessary.

PROPERTIES OF DEPOSITED METAL

Welds are free from porosity and can be polished equally as well as the base metal.

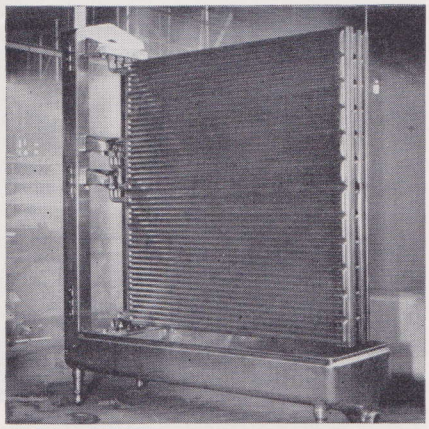
Average chemical analysis of all-weld metal deposit: .08% carbon, 22.9% chrome, 13.8% nickel, .80% columbium.

Shape of bead generally is flat. Properties of all-weld metal specimen (average for various sizes of electrodes):

AS WELDED:

Tensile strength—85,000 to 95,000 lbs. per sq. in.

Elongation in 2 inches—30% to 45%.



Milk cooler of 25-12 stainless steel in process of construction with "Stainweld B-Cb."

PROCEDURE

POLARITY—Electrode positive, work negative.

Proceed as with mild steel, only take into account higher electrical resistance, lower thermal conductivity and higher thermal expansion (about 50% greater than mild steel). Prepare and fit work carefully and clean joint of all foreign material.

Hold as short an arc as possible without sticking. For best results use only enough current to obtain a free-flowing arc and proper fusion to base metal. Avoid excessive weaving. A number of straight beads are preferable.

When more than one bead is used, thoroughly clean the slag from the preceding bead. Thin sheets should be clamped against a copper or steel backing to maintain alignment of the seam and prevent burning through.

WELDING VERTICAL AND OVERHEAD—Use smaller sizes (up to 5/32") with amperage in lower portion of range. In overhead welding, build the weld with several normal beads without weaving.

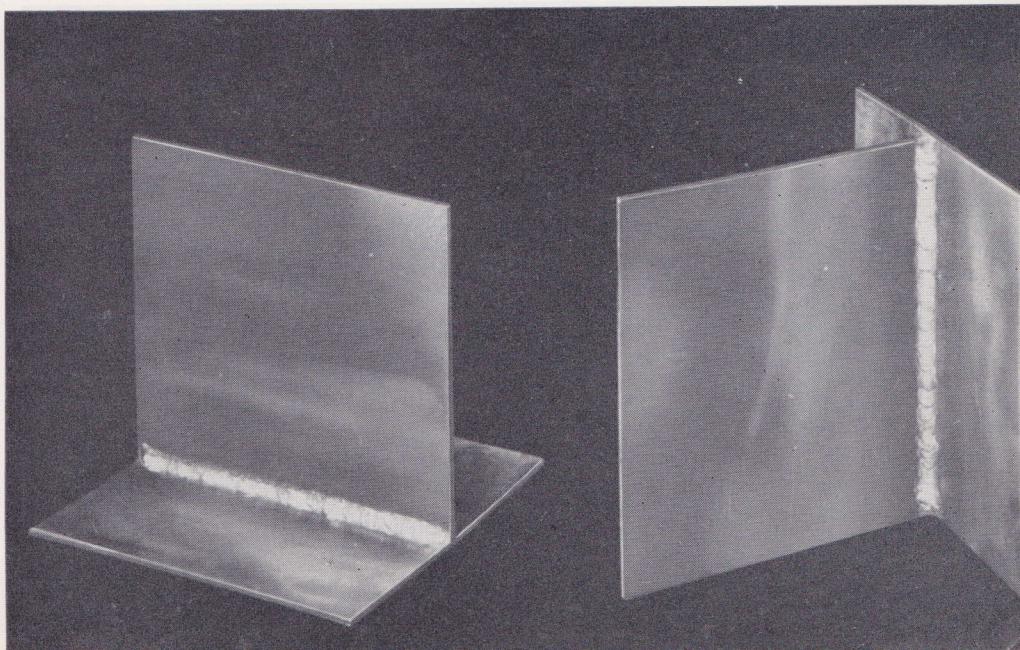
FLAT, VERTICAL & OVERHEAD	
Rod Size	Amperage Range
3/32"x 9"	30– 70
1/8" x14"	50–100
5/32"x14"	75–130
3/16"x14"	95–165

Standard containers for 14" length—50 lbs.; for 9" length—25 lbs.

Fillet welds in 16 gauge 25-12 stainless steel made with "Stainweld B-Cb". Left: Down-hand weld. Right: Vertical weld, welded upward.

TYPICAL APPLICATIONS

Acetic acid line
Glass furnace chutes
Heat exchangers
Carburizing boxes
Caustic soda storage tanks
Welding high manganese steel
Stainless clad tanks
Hoods for acid fumes
Relining cracking towers
Salt manifolds
Boiler soot blowers
Heat treating cyanide pots
Dairy equipment
Blast furnace nozzle burners
Welding 18-8 to mild steel



Class—**E-316Cb-15**
Coating—Light Green
Code—(E) Yellow
(S) Green
(G) Black

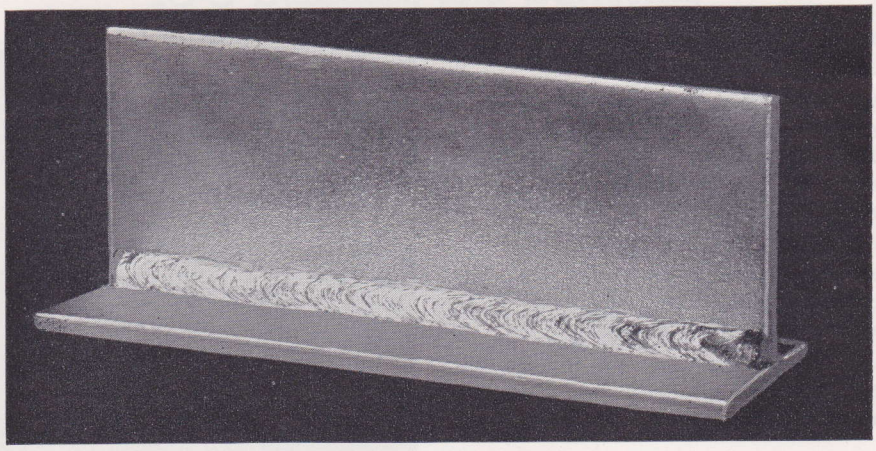
STAINWELD C-Cb

Lime Coated D. C. Electrodes for Welding 18-12 Mo Stainless

APPLICATION

"Stainweld C" is a shielded arc electrode for all-position welding of the stainless steels of Type 316 and 316 L.

Molybdenum content of approximately 1.8%–2.50% gives these steels greater resistance to corrosion of certain chemicals than does the 18-8 type. They are used extensively in process industries for piping coils, vats, digesters and other equipment subject to heat and corrosion, particularly sulphuric corrosion.



Fillet weld in 3/16-inch Type 316 stainless steel plate welded with "Stainweld C."

PROPERTIES OF DEPOSITED METAL

Welds are free from porosity and can be polished as well as the base metal.

Average chemical analysis of all-weld metal deposit: .065% carbon, 18.1% chrome, 12.5% nickel, 2.1% molybdenum, .80% columbium.

High resistance to corrosion by certain chemicals (comparable to parent metal).

Properties of all-weld metal specimen (average for various sizes of electrodes):

AS WELDED:

Tensile strength—85,000 to 95,000 lbs. per sq. in.

Elongation in 2 inches—30% to 45%.

PROCEDURE

POLARITY—Electrode positive, work negative.

Proceed as with mild steel, only take into account higher electrical resistance, lower thermal conductivity and higher thermal expansion (about 50% greater than mild steel). Prepare and fit work carefully and clean joint of all foreign material.

Hold as short an arc as possible without choking or sticking. For best results use only enough current to obtain a free-flowing arc and proper fusion to base metal. Avoid excessive weaving. A number of straight beads are preferable.

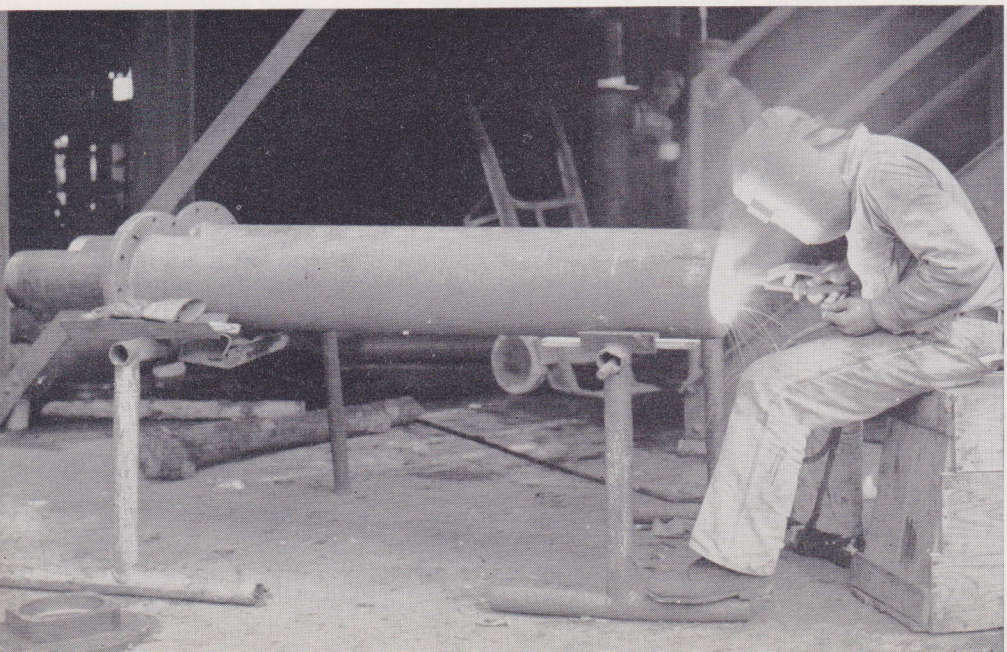
When more than one bead is used, thoroughly clean the slag from the preceding bead. Thin sheets should be clamped against a copper or steel backing to maintain alignment of the seam and prevent burning through.

OVERHEAD AND VERTICAL WELDING—Use 1/8" to 5/32" size with amperage in lower portion of range. Do not weave.

FLAT, VERTICAL & OVERHEAD	
Rod Size	Amperage Range
1/8" x14"	45– 95
5/32"x14"	80–135
3/16"x14"	100–165

Standard container—50 lbs.

Welding a Type 316 stainless steel liner in a pulp-mill smelter blow nozzle with "Stainweld C-Cb."



TYPICAL APPLICATIONS

Dyeing equipment
Valves
Agitator coils
Dye kettle drums
Paper mill tanks
Baking equipment
Chemical mixers
Heat resisting castings
Chemical containers
Salt processing equipment
Pump linings
Evaporators
Alkali equipment
Chicken eviscerators
Combustion chamber parts
Pickling tanks

STAINWELD D

Lime Coated D. C. Electrodes for Welding 25-20 Stainless and Surfacing

Class—**E-310-15**
Coating—Light Green
Code—(E) Red
(G) Black

APPLICATION

"Stainweld D" is a shielded arc electrode for welding stainless steel of the 25% chromium, 20% nickel type such as Iron & Steel Institute No. 310. It is also used for welding various stainless steels to mild steel.

PROPERTIES OF DEPOSITED METAL

A fast flowing electrode which produces an exceptionally smooth bead with corrosion resistance equal to or greater than that of the parent metal. Weld can be ground and polished with perfect results.

Average chemical analysis of all-weld metal deposit: .13% carbon, 25.8% chrome, 20.4% nickel.

Physical properties of all-weld metal specimen (average for various sizes of electrodes):

AS WELDED:

Tensile strength — 80,000 to 90,000 lbs. per sq. in.

Elongation in 2 inches—35% to 45%.

PROCEDURE

POLARITY—Electrode positive, work negative.

Butt weld in 25-20 stainless steel welded in vertical position, upward, with "Stainweld D."

Proceed as with mild steel, only take into account higher electrical resistance, lower thermal conductivity and higher thermal expansion (about 50% greater than mild steel). Prepare and fit work carefully and clean joint of all foreign material.

Hold as short an arc as possible without choking or sticking. For best results use only enough current to obtain a free-flowing arc and proper fusion to base metal. Avoid excessive weaving. A number of straight beads are preferable.

When more than one bead is used, thoroughly clean the slag from the preceding bead. Thin sheets should be clamped against a copper or steel backing to maintain alignment of the seam and prevent burning through.

WELDING VERTICAL AND OVERHEAD—Use smaller sizes (up to 5/32") with amperage in lower portion of range. In overhead welding, build the weld with several normal beads without weaving.

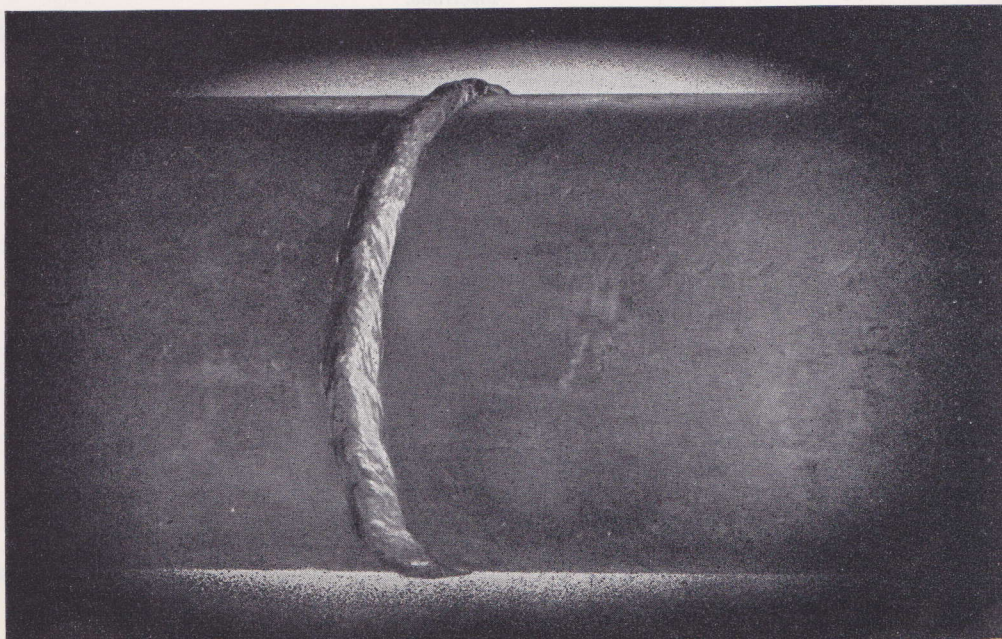
FLAT, VERTICAL & OVERHEAD	
Rod Size	Amperage Range
3/32"x 9"	30– 70
1/8" x14"	45– 95
5/32"x14"	80–135
3/16"x14"	100–165
1/4" x14"	140–225

Standard containers for 14" length—50 lbs.; for 9" length—25 lbs.

TYPICAL APPLICATIONS

Piping
Storage tanks
Soap kettle liners
Heat treating baskets
Valves
Auto springs
Annealing boxes
Carburizing pots
Stainless to mild steel
Aircraft parts
Broken dies and tools

Joint in 3-inch pipe of 25-20 stainless steel welded with "Stainweld D."



Class—**A1-43**

Coating—Peach

Code—(none)

ALUMINWELD

For Welding Aluminum

APPLICATION

"Aluminweld" is a 5% silicon aluminum alloy shielded arc electrode for welding aluminum in any form —cast, sheet, shapes or extruded forms. Designed for either metallic or carbon arc welding. Conforms to AWS Class A1-43.

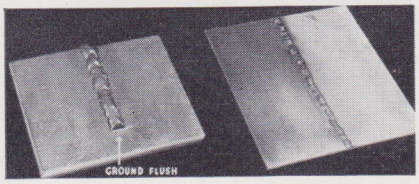
PROPERTIES OF DEPOSITED METAL

It is provided with a coating which prevents excessive oxidation and will dissolve any aluminum oxide which might be formed. The coating also assists in giving a very smooth operating arc which is so particularly essential in welding aluminum. The resulting weld is without porosity and possesses high tensile strength. The weld can be polished satisfactorily with practically no discoloration.

PROCEDURE

POLARITY — Electrode positive, work negative.

A short arc should be held, the coating approximately touching the molten pool.



Left: Butt weld in 1/8-in. aluminum made with "Aluminweld" and ground down at end to show denseness of weld metal. Right: Butt weld in 14-gauge aluminum made with "Aluminweld."

In general, use the highest current possible without melting the edges too far back or burning through. With the high melting rate of aluminum, little heat is dissipated into the plate with consequent chilling of deposits. Hence, it is sometimes desirable to preheat the seam to 600° to 700° F. before welding.

On striking, the best results are obtained by "scratching" the electrode. To start an electrode, strike the arc in the crater, then move the electrode quickly back along the completed weld for 1/2", then proceed as usual, making sure the crater is completely remelted.

Even melting off of the flux is facilitated by holding the electrode approximately perpendicular to the work at all times.

Always direct arc so that both edges to be welded are properly and uniformly heated and the electrode advanced along the seam at such a rate that a uniform bead is made.

TACKING—Increase recommended currents approximately 50% for tacking. Use short arc and rotary motion.

Remove slag from the weld by light hammering and brushing. Last traces may be removed with warm water and a wire brush or by soaking the weld in 5% nitric acid or 10% warm sulphuric acid followed by a warm water rinse.

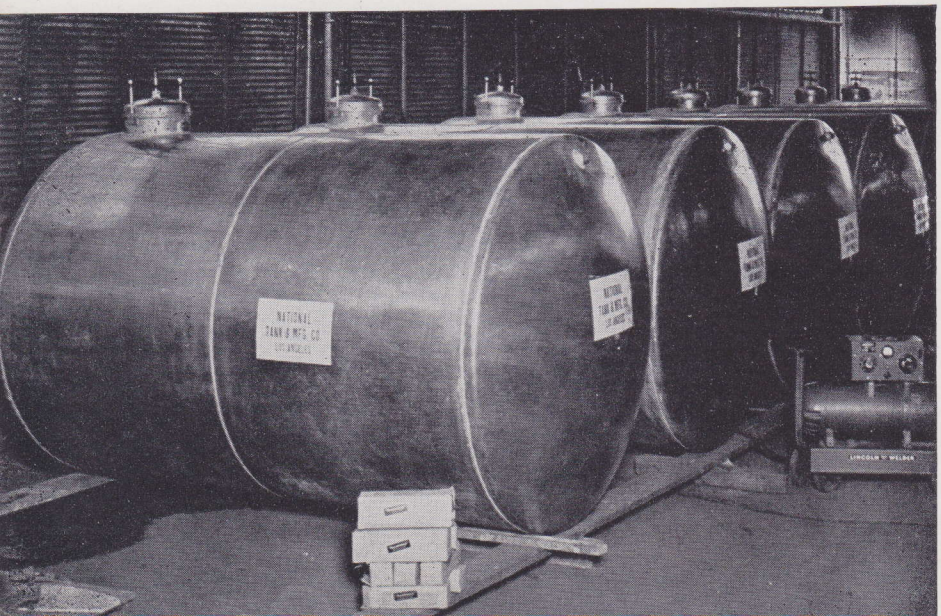
Vertical and overhead welding should as far as possible be eliminated. However, where imperative, vertical welding can be done downward or upward with straight beads or by weaving. Overhead welding should be done with a number of straight beads.

"Aluminweld" produces excellent welds used as a filler rod with the carbon arc.

FLAT	
Rod Size	Amperage Range
3/32"x14"	20– 55
1/8" x14"	45–125
5/32"x14"	60–170
3/16"x14"	85–235
1/4" x14"	125–360
VERTICAL & OVERHEAD	
Not recommended. However, where vertical or overhead welding is required, follow same procedure as for flat work, using 3/32", 1/8" or 5/32" electrodes.	

Standard Container: 10 lbs.

Group of aluminum storage tanks for olive oil. Fabricated with "Aluminweld" Electrode.



TYPICAL APPLICATIONS

- Bottle brackets
- Racks
- Cylinder heads
- Ornamental work
- Laundry chutes
- Viscose plant piping
- Beer barrels
- Outboard motor gas tanks
- Moulding
- White metal die castings
- Washing machine tubs
- Tanks
- Crank cases
- Transport truck tanks
- Cooking utensils
- Portable drill castings
- Appliance parts
- Structural aluminum
- Trim
- Window frames
- Soap kettle liners

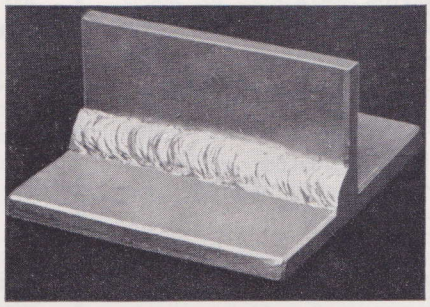
AERISWELD

For Welding Bronze, Brass and Copper

Class—**E-CuSn-C**
Coating—Peach
Code—(E) Yellow
(S) Blue
(G) Blue

APPLICATION

"Aerisweld" is a shielded arc electrode for welding bronze, brass and copper in the many applications. In repair work, "Aerisweld" builds up and fills in bronze castings. Many types of bronzes which are difficult to braze are easily welded with "Aerisweld." Conforms to AWS Class E CuSn-C.



Fillet in 3/16-in. bronze plate welded with "Aerisweld."

PROPERTIES OF DEPOSIT

Dense, high-strength deposit with characteristics of true phosphor bronze.

Characteristics of the base metal are of great importance in determining the characteristics of the joint, and fusion zone due to possible admixture of base metal in welding.

PROCEDURE

POLARITY — Electrode positive, work negative.

On ferrous metal or thin copper or bronze, it is generally unnecessary to preheat the metal. As the work progresses and the heat builds up, it may be necessary, in some cases, to reduce the current.

On heavy copper and bronze, preheating may be necessary due to the high heat conductivity of these metals. This preheating can be accomplished by using a carbon electrode with negative polarity and rapidly moving the arc over the area to be welded.

High current, high temperatures, or considerable penetration will cause a great admixture of the base metal and the procedure should take this into account in the case of the first layer. It is therefore advisable to put on as much metal per bead, or layer, as can be conveniently and easily done.

Types of metals which evolve gases in the molten state, at the point of solidification, result in porosity. In some cases the use of higher current, keeping the work hot, will tend to reduce this porosity.

Holding the electrode at an angle so that the flame of the arc is directed back over the work will aid in permitting the gases to bubble through to the surface.

Where the work has to be machined it is, of course, necessary that the original, or base metal, be cut away so that when the deposit is made the line of machining will come through near the top of the deposit and not at the junction zone. The work should be laid out to obtain this result.

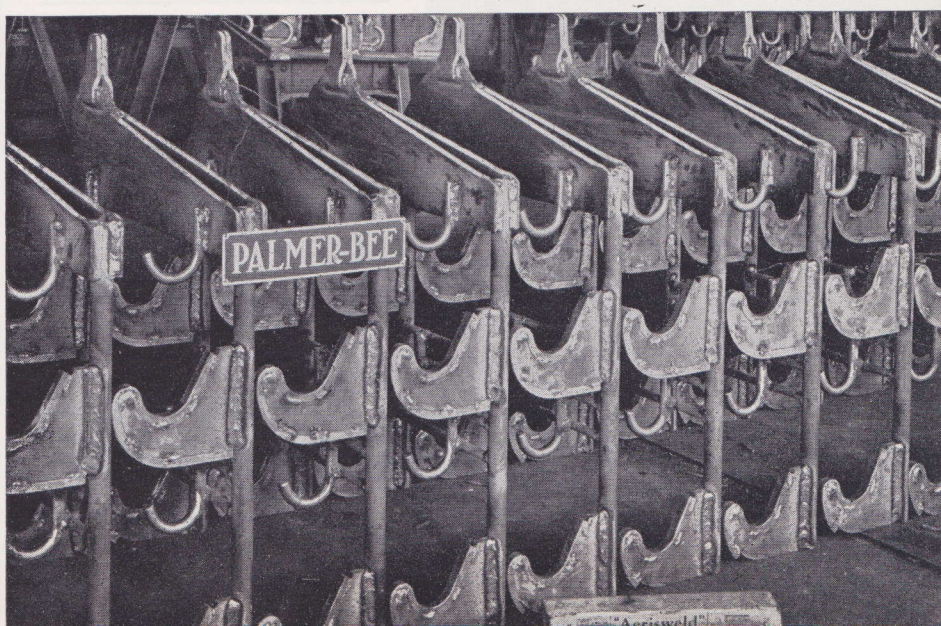
ALL POSITIONS	
Rod Size	Amperage Range
1/8" x14"	50–125
5/32"x14"	70–170
3/16"x14"	90–220

Standard Container: 10 lbs.

TYPICAL APPLICATIONS

Contact points
Bearing surfaces
Cast iron
Galvanized iron
Copper rivet heater blocks
Fire hose couplings
Copper piping
Copper-to-steel
Viscose mixers
Brass pads on steel
Ornamental work
Bonding rails
Repair brass valves
Impeller blades
Bus bars
Malleable iron
Bronze ship propellers
Bronze check valve discs
"Ground" connections
Bronze tubing
Copper vats
Copper clad fabrication
Bushings
Pipe line bonds
Caustic pump blocks
Copper brew stills

Racks for storage of machined parts. Bronze cushions are welded on steel brackets with "Aerisweld."



Coating—Light Tan
Code—(E) Orange

FERROWELD

For Welding Cast Iron

APPLICATION

"Ferroweld" is a shielded arc electrode of the mild steel type for welding cast iron. It is intended for use where extreme machinability is not required.

PROPERTIES

Provides welds of greater tensile strength than the cast iron itself. Low heat with which it can be used minimizes possibility of either the weld or the work cracking. Also minimizes the usual hardening effect along the line of fusion. Thus the weld is much more machinable than welds made by most rods for cast iron welding. Where studding is required, "Ferroweld" metal fuses with the studs equally as well as with the casting providing an exceptionally strong, ductile weld.

Quality of welds is dependent upon the condition of the base metal. On a good grade of iron casting—one that is clean—"Ferroweld" will produce thoroughly tight and strong welds.

PROCEDURE

POLARITY—Electrode positive, work negative, or A.C.

Hold a close arc but do not allow coating to touch molten metal.

Caution—On larger parts which cannot be preheated uniformly DO NOT ALLOW WORK TO GET TOO HOT. Keep it cool enough to be able to touch it with the hand.

If the weld area is to be painted, after the weld has cooled, remove the slag from the weld by any convenient mechanical means such as grinding, sand blasting, chipping and wire brushing. Swab the weld and adjacent parent metal with a 10% sulphuric acid solution, preferably warmed to 150°-180°F. Allow the acid to act for a few minutes. Rinse off the acid with hot water and at the same time scrub the weld area with a wire brush. Allow to dry before painting.

ALL POSITIONS	
Rod Size	Amperage Range
1/8″x14″	80–100

Standard Container: 50 lbs.

Crack in cast iron cylinder head welded with "Ferroweld."

Press frame repaired with "Ferroweld" after studding both sides of crack.

Procedure for Arc

All types of cast iron are welded satisfactorily when proper precautions are taken for:

1. Uneven expansion
2. Welding metallurgy
3. Joint preparation

1. EXPANSION. Cast iron has high compression strength but is relatively weak in resisting tensile stress, and any strong, localized stresses may cause cracks or fractures. Localized stress can be minimized by first uniformly preheating the part prior to welding and avoiding rapid cooling by covering the part with sand or asbestos after welding. Where preheating is not practical, special care must be taken to weld only a little at a time (2″ or 3″ length of bead at most). Peen each short weld before proceeding with the next bead in order to avoid high stresses due to localized overheating.

2. WELDING METALLURGY. Cast iron contains both free graphite and combined carbon. The faster that cast iron is cooled, from above the critical temperature, the greater the percentage of carbon which is combined with the iron to form a hard, brittle metal.

During welding, with "Ferroweld," the molten pool of weld metal absorbs some of the carbon from the cast iron creating a bead of high carbon steel. Under rapid cooling, the high carbon steel becomes extremely hard and unmachinable. Furthermore, the difference in contraction rate between cast iron and the steel creates localized stress causing hairlike cracks along the weld in the weaker cast iron, particularly where the bead is long. As a result, welds must be short and peened after laying every bead.

Welding for Machinability. "Softweld" electrode is desirable where machinability is important as in correcting machining errors and filling up defects in castings. "Softweld" avoids absorption of free carbon from the cast iron eliminating a hard weld.

3. *PREPARATION FOR WELDING.* When welding a cracked casting *be sure first that the casting is clean*—remove all the dirt and grit. Put kerosene or penetrating oil over the entire area surrounding the crack. After several minutes, wipe off the kerosene or oil with a clean dry cloth.

SOFTWELD

For Machinable Welds in Cast Iron

Class—**E-3N-11**
Coating—Black
Code—(E) Orange
(S) Blue
(G) White

Welding Cast Iron

Next, rub a piece of white chalk over the area where the crack may be. In a few seconds a "wet" line will indicate exactly where the crack is. *This is important.* In welding cast iron it is necessary to keep the crack from spreading. With a center punch, mark the work a little beyond the end of each crack and drill a 1/8″ hole. This stops the crack from going any farther and indicates the thickness of metal at that point.

Vee all cracks approximately 1/8″ to 3/16″ deep with a diamond point chisel. If the material is less than 3/16″ thickness, vee only one-half the thickness.

Welding. The electrode to be used is 1/8″ "Ferroweld" with approximately 90 amperes current. If the weld is to be machined later, "Softweld" is preferred.

Start welding approximately 3/8″ away from the crack and weld back to the hole, filling it. Then move slightly beyond the hole. *Do not leave a crater where the hole formerly was.* Next, move over to the opposite end of the crack and proceed in the same way. Alternate the welds, back and forth, as not to heat up one section any more than necessary. *Peen each short bead carefully before starting the next bead. Weld a little and cool a lot.* If possible, always use a back stepping technique so as to finish each bead on top of a bead previously made. Make welds only 1/2″ long on thin material and no more than 1″ long on heavy material. Allow each bead to cool so that the bare hand can be placed on it without discomfort before making the next weld.

When welding a good grade of casting (that is clean) tight welds are secured by using "Ferroweld." However, some castings become oil soaked, or are dirty, and the best of electrodes cannot compensate for this. As a result, some few pin holes may be produced.

If the casting is oil soaked, or if oil has been used to locate the crack as recommended previously, frequent heating ahead of the weld will drive the oil out and permit a tight weld being made. After the weld is completed and the metal is still warm, apply sulphur to the joint being sure it is melted in so that the pin holes are sealed.

Unusual Cases Where Pieces Are Knocked Out. In cases where there are big holes or parts are knocked out, fit the pieces together carefully. Vee the break and tack the pieces together first to form a single piece before welding the break.

APPLICATION

"Softweld" is a shielded arc electrode for depositing a soft-machinable non-ferrous alloy on cast iron. It is used chiefly for correcting machining errors, filling up defects and making other repairs in gray cast iron.

PROPERTIES

Softweld is designed to cause the weld to flow over and bond to the cast iron with minimum penetration and heating of the base metal. Where a single layer deposit will be machinable, the use of at least two layers is recommended in order to obtain a soft fusion zone. The entire weld area may then be machined, sawed, drilled or tapped with ease.

PROCEDURE

POLARITY—Electrode negative, work positive. A.C. may be used.

Use a fairly long arc, approx. 1/8″. Weave the electrode slightly from side to side.

Since localized heating of cast iron may cause it to crack, care must be taken to either heat it uniformly or to keep it cool. When it is practical to do so, preheating of the entire casting is recommended. A dull red preheat is recommended, but a preheat lower than dull red will be helpful in producing a soft fusion zone and in preventing porosity.

Where there is a large or deep area to be filled, or where a strength weld is required, the most economical procedure is to use "Ferroweld" up to within approximately 1/8″ of the surface to be machined and then finish off with several layers of "Softweld."

Porosity in the deposited weld metal can be caused by moisture in the pores of cast iron. To overcome porosity difficulties preheat to 350°F. for one hour or 500°F. for one-half hour.

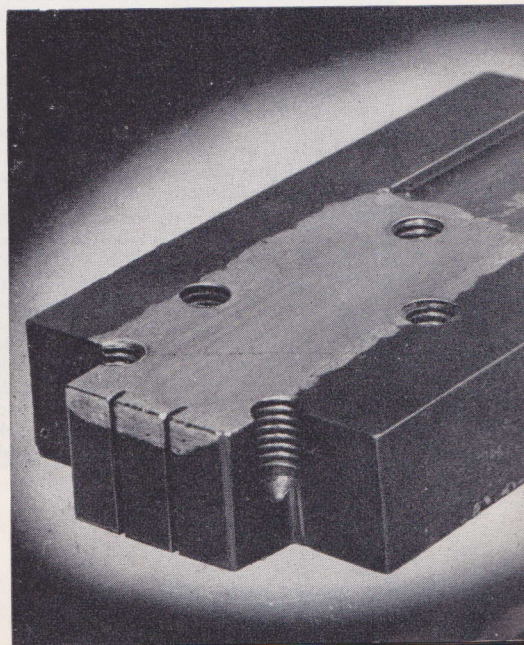
CURRENT RANGE	
Rod Size	Amperage Range
5/32″x14″	75–110
1/8″ x14″	90–135

Standard Container: 10 or 50 lbs.

Deposit of "Softweld" on cast iron readily cut, drilled and tapped in deposit and at line of fusion.

TYPICAL APPLICATIONS

- Defective castings
- Correcting machining errors
- Filling in sand pockets
- Filling in drill holes
- Auto blocks and heads
- Cylinder wall defects
- High nickel castings
- Impeller rings
- Valve seats
- Motor exhaust ports
- Gears
- Sprockets
- Cast iron dies
- Dairy metals



Introduction to Arc Weld Surfacing

Arc weld surfacing—the process of building up a layer of metal or a metal surface by electric arc welding—has almost unlimited scope and possibilities. Some examples of the varied applications are: building up a worn shaft with a low carbon steel deposit; lining a carbon steel vessel with a stainless steel corrosion-resisting alloy deposit; depositing a tool steel cutting edge on a medium carbon steel; and the application of wear resisting surfaces to metal machine parts of all kinds.

The success of a given arc weld surfacing application, depends largely on the proper choice of surfacing materials. Things to take into consideration in choosing a surfacing material are outlined below.

1. SERVICE REQUIRED
   - A. Cutting edge to be maintained.
   - B. Two surfaces in contact—both to be protected.
   - C. One surface to be protected.
2. SERVICE CONDITIONS
   - A. Abrasion.
   - B. Impact.
   - C. Corrosion.
3. PART TO BE SURFACED
   Its composition and its physical condition such as hardness, previous heat treatment, etc.
4. DIMENSIONS
   - A. Size and shape of parts
   - B. Size and location of area surfaced.
   - C. Thickness of weld deposit.
5. FINISH REQUIRED

The following is a point-by-point discussion of the above factors.

1. SERVICE REQUIRED

A. Cutting Edge to be Maintained

(1) Wear of the edge affects the efficiency of the part.

Shear blades, punches and metal cutting tools must not only stay sharp but they must also hold their original size and shape to operate satisfactorily. Failure of these parts is usually by upsetting, chipping, spalling, or galling—due to the high compressive loads, and also due to the flow of the metal being cut past the edge of the tool. Impact and abrasion are not excessively high. The "Toolwelds" are used for this application for they give an edge of high strength, are homogeneous, resist galling, and in addition "Toolweld 60" has high strength at elevated temperatures.

(2) Wear of the edge does not impair the operation of the part.

On earth cutting tools—such as plow points, blades of rotary drilling bits, scrapers, ensilage knives, and shredder blades—the edge must stay sharp but the tool may wear back. In fact these tools are intentionally surfaced with a layer of wear resistant material on the advancing edge so that the backing metal may wear and keep a fresh sharp edge of the surfacing material exposed for fast cutting. Materials most resistant to abrasion are used for these applications. "Tungweld C" will give the longest life on earth cutting tools in sandy formations, it wears to give a rough edge. "Tungweld F" is used when a smoother and sharper edge is needed, for example on ensilage knives. The "Facewelds" are used on tools when the abrasive conditions are not so severe or when a lower cost material is desired. "Abrasoweld" is unsurpassed when the impact is high and a medium sharp edge is satisfactory. "Surfaceweld" may be deposited in a thin layer which is highly abrasion resistant.

B. Two Surfaces in Contact—Both to be Protected

Examples: Machine parts—
- Lubricated
- Not adequately lubricated
- Elevated temperature operation

Chain links
Valve gate and seat
Rolling mill back-up rolls

This group includes metal-to-metal wear under various combinations of abrasion, impact and corrosion. Surfacing materials which will wear smooth, have low friction, and will have a minimum tendency to seize or gall are desired. The "Tungwelds" are not recommended for this service, for they do not wear smooth.

When the unit loads are not excessive and the abrasive action is not severe, "Aerisweld" is used to deposit a bronze-like bearing surface.

The "Facewelds" are used when the abrasive conditions are severe; in particular when parts are operating, non-lubricated or in sandy mud.

"Abrasoweld," "Wearweld," "Manganweld," "Stainweld," and the "Hardwelds" are used to combat this type of wear, the choice depending upon the service conditions.

C. One Surface to be Protected

Application	*Recommended Material*
Railends	"Wearweld"
Mine car wheels	"Hardweld"
Crusher jaws	"Manganweld" "Abrasoweld"
Sand pump impellers	"Abrasoweld"
Small bucket lips	"Surfaceweld"
Screw conveyors	"Faceweld No. 12"
Scarifier teeth	"Faceweld No. 1"
Forging dies	"Toolweld A & O"
Tool joints (O.D.)	"Tungweld"
Water turbine blades	"Stainweld A"

This group covers cases where we protect one of the two contacting materials and the wear of the other material is of little or no importance. In some cases it is desirable to have a low friction surface that will polish (a plow landslide for example), and in others a rough high friction surface as in the case of dredge stud clamps.

2. SERVICE CONDITIONS

The various service conditions to which a weld-faced deposit may be subjected can be classified as follows:

A. Abrasion

(1) Grinding action due to rubbing against an abrasive material such as rock, sand, clay or soil.

(2) Sliding, rolling or rubbing action of one metal part against another.

Both (1) and (2) may take place under low or high pressure.

B. Impact

In various degrees from light to heavy. It tends to deform the surface or cause cracking or chipping.

C. Corrosion

This includes the action of various chemicals, ordinary water (rusting) and also oxidation or scaling at elevated temperatures.

It is obvious that before the proper choice of weld-surfacing material can be made for a given application, the service conditions must be known. In most applications more than one of the above factors are at work and it is then necessary to evaluate the relative importance of each. These factors will be discussed later in connection with Lincoln weld-surfacing electrodes as to their relative abilities to withstand such conditions.

On the chart, page 4, are plotted the Lincoln Arc Weld Surfacing Materials according to their resistance to abrasion and to their resistance to impact. Use of this chart will assist in the selection of the best surfacing material.

3. PART TO BE SURFACED

Composition and Physical Condition

There are thousands of alloy compositions used in parts or equipment that wear or corrode in service. It is obvious that only a few of these can be considered in this discussion. Regarding their suitability as a base metal for weld-surfacing, they can be divided into two general groups:

GROUP A—Those metals or alloys whose physical characteristics are not greatly changed as a result of heating and cooling, and which will withstand sudden localized temperature changes without cracking. This group includes plain carbon steel with .30 carbon maximum, low carbon low alloy steels, austenitic steels such as the stainless chrome-nickel, and the high manganese steels. Copper and most of its alloys would also be included.

GROUP B—This includes those metals or alloys whose physical characteristics are changed considerably, (particularly as to hardness) as a result of the application of welding heat and subsequent cooling, or which will crack with sudden localized application of heat. This group includes medium to high-carbon steels, tool steels, medium to high-carbon low-alloy ferritic steels, cast irons (grey, white, malleable, chilled), semi-steel and, in general, all hard metals and alloys.

In general, metals of *Group A* may be weld-surfaced without any particular precautions such as preheating, since the thermal cycle incident to the weld-surfacing operation will cause no harmful cracking or hardening adjacent the weld.

Special precautions must be taken in weld-surfacing metals of *Group B*. In general, if an arc is struck on a metal which is very hard, it will crack due to thermal shock. To avoid or minimize this thermal cracking, we must either reduce the hardness by annealing or reduce the thermal shock by gradual and uniform preheating, or both, depending on the nature of the alloy. Thermal cracking can thus be prevented in most steels. For grey cast iron which is already in its soft condition, but is still brittle, and chilled iron which is hard and very brittle, but cannot be annealed easily, there is little that can be done beyond moderate uniform preheating, which will decrease tendency for thermal cracking. This does not necessarily mean that cast iron should never be weld-surfaced.

The second precaution in weld-surfacing *Group B* metals is to minimize the hardening of the metal adjacent the weld. High weld-surfacing temperatures which cause solution of free carbides, followed by fast cooling, cause hardening, which may result in cracking of the hardened area, failure of the part or spalling of the weld deposit. To reduce the tendency to weld-harden, preheating, slow-cooling and post heating, or a combination of these may be employed.

In general, preheating to 300 to 500° F will prevent weld-hardening in medium to high-carbon steels. With medium-carbon alloy steels, preheating as above plus slow cooling as in lime, may be necessary. With high carbon alloy steels such as tool steels and other special wear resisting alloys, preheating followed by reheating after welding to a temperature in the 800 to 1300 degrees range and uniform cooling may be necessary.

Controlled uniform slow-cooling is always desirable for cast irons to prevent cracking, but their tendency to weld-harden is so great that little can be done to overcome it. When cast iron is weld-surfaced, it is usually a case of building up a hard wear-resisting surface. Usually the part is made of chilled cast iron. The success of this application depends greatly on the choice of surfacing material. The most successful work is done with a deposit which tends to cross-crack on cooling—such as "Faceweld No. 12." These cross cracks tend to relieve the cooling strains and prevent the weld surface from peeling off in spite of the brittle base metal under the bond.

In most cases where the original chilled iron part was not too brittle for the service conditions involved, the weld-surfaced part will also stand up with the added advantage of a superior abrasion resisting surface. In most cases the cross cracks will not be detrimental. If a strong, tough deposit such as "Abrasoweld" is applied to chilled cast iron, the shrinkage strains will be relieved by cracking under the deposit with the result that the weld-surfacing will break away.

4. DIMENSIONS

A. Size and shape of parts—The heat capacity of the part to be weld-surfaced is largely a function of its size and shape. A part of large heat capacity will heat up slowly during the surfacing operation, reach a relatively low maximum temperature and draw the heat away from the weld area very rapidly. Conversely, a small part or a thin section will heat up rapidly (at least locally), reach a higher maximum temperature and draw the heat away from the weld area very slowly. The mass of the metal being surfaced, therefore, determines to some extent the thermal cycle to which it *and* the deposit are subjected. For this reason, if local welding heat is applied to a large mass of cold metal which is capable of being quench-hardened, the hardening will be very drastic, and cracking is likely to occur because of steep temperature gradients which result in severe thermal stresses. If the mass is small, the degree of hardening will be less because of its low heat capacity and cooling will be more uniform throughout, resulting in less severe thermal stresses. If the weld-facing material applied in the above examples happens to be one of the type whose hardness is affected by the thermal cycle ("Hardweld" for example), the hardness of the deposit will be much greater in the case of the large mass because of its quench effect.

B. Size and location of area surfaced—will determine the heat input and therefore the thermal cycle as above. Location or position of weld will influence the choice of material to some extent. Very small areas require the use of small electrodes. For various reasons, small electrodes are not available in all types and a second choice must be made. Weld-surfacing materials, particularly those intended for hard-facing, are not well adapted for use in vertical and overhead positions. In general, the cost of doing a job will be much lower if the work can be located so that the welding can be done in approximately a flat position.

C. Thickness of weld deposit—The best general rule to follow is to avoid thick deposits of the hard alloys. If a large amount of build up is necessary, this should be done with "Fleetweld," "Hardweld 50" or "Hardweld 100." Thick deposits may also be applied with "Stainweld" or "Manganweld."

5. FINISH REQUIRED

If the weld-surface must be machined, the following deposits can be used in their as-deposited condition:

"Fleetweld," "Shield-Arc 85," "Shield-Arc 90 CM," "Aerisweld," "Stainweld," "Softweld," "Hardweld 50."

The following deposits are not machinable in their as-deposited

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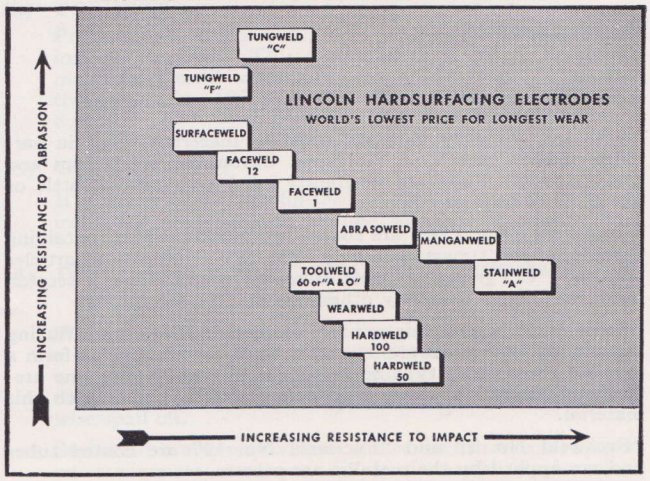


condition, but are when softened by annealing: "Hardweld 100," "Toolweld A & O," "Toolweld 60," "Wearweld" and "Abrasoweld."

"Faceweld," "Surfaceweld A," and "Tungweld" deposits are ground if shaping is necessary.

As a matter of convenience in this discussion, the Lincoln line of arc weld-surfacing materials can be divided into three groups, according to the type of deposit they produce. The mild steel and high tensile low alloy steel deposits will not be included here, as their properties are well known.

TYPES OF ELECTRODES

FERRITIC TYPE

"Fleetweld"
"Shield-Arc"

MARTENSITIC TYPE

(Listed in their order of increasing hardness)

"Hardweld 50"
"Hardweld 100"
"Wearweld"
"Toolweld A & O"
"Toolweld 60"

Deposits of this group show practically their full hardness in the as-deposited state—that is, they show a relatively small increase in hardness on cold working. They are heat-treatable straight carbon or alloy steels and may be annealed to reduce hardness, and quenched from above their critical temperatures to harden. For this reason, the deposit hardness may also vary somewhat because of variable welding thermal cycles. Of these the "Toolweld" deposits are the highest in alloy content and the most stable in hardness variation. In general, the higher the hardness of the deposit in this group, the better the resistance to wear and deformation and the lower the resistance to impact or chipping.

AUSTENITIC TYPE

"Stainweld"
"Manganweld"
"Abrasoweld" (semi-austenitic)

Austenitic deposits differ from the Martensitic principally in that they possess the property of hardening at the surface when deformation takes place as in peening or cold working—the rest of the deposit remaining relatively soft and tough.

"Stainweld," "Manganweld" and "Abrasoweld" differ principally in their capacity for work-hardening. "Abrasoweld" has the highest initial hardness of this group, work-hardens very rapidly and to the greatest degree with the least amount of cold-working. "Stainweld," on the other hand, is the softest of the group as-deposited and shows the lowest rate of work-hardening. However, the amount of work-hardening in a "Stainweld" deposit is much more than is generally realized and this, together with its exceptionally high degree of toughness and resistance to corrosion makes it a very useful electrode for many arc weld-surfacing applications.

CARBIDE TYPE

"Tungweld F" and "C"
"Faceweld No. 1" and "No. 12"
"Surfaceweld"

These are primarily abrasion resisting materials, high in carbides of such metals as Tungsten, Chromium, Vanadium and Molybdenum. They are inherently hard and respond little or not at all to heat treatment.

"Tungweld F" and "C" are coated tubular electrodes containing particles of cast tungsten carbide. The "F" deposits fine particles and the "C" granules. Cast tungsten carbide has a scratch hardness greater than any other weldable material.

"Surfaceweld" is a mixture of powdered alloys and fluxing ingredients. A carbon arc is used to melt these alloys to form a layer of the carbide type deposit right in place during the arc-surfacing operation. Very thin deposits are possible with this material.

"Faceweld No. 1" and "Faceweld No. 12" are coated tubes and are applied by the metallic arc process.

USE OF STAINLESS STEEL ELECTRODE

The Lincoln "Stainweld" series of electrodes can be used to good advantage for the welding of wear resisting materials and building up of worn areas where certain service conditions exist.

Because of the high strength of Stainless steel weld metal, its austenitic state and minimum tendency for admixture with the parent metal, and because of the peculiar low hydrogen type of coating which minimizes tendency for under bead cracking, "Stainweld" electrodes can be used readily for making strength welds under the following conditions:

1. Repairing broken tools, dies, etc., made of high carbon or high alloy steel.

2. Repairing broken manganese steel parts. "Stainweld" deposits will give a much stronger weld than either bare or coated manganese steel electrodes often used. Sometimes the complete repair is made with "Stainweld" electrode and in other cases, which are not critical, the surfaces to be welded are merely "buttered" with Stainless steel and then welded with a manganese steel electrode, such as "Manganweld B". In many cases, the root weld between two broken pieces is also made with "Stainweld".

3. Welding carbon steel to Manganese steel can best be accomplished with stainless steel electrode, by "buttering" the carbon steel edges with "Stainweld" and then completing the job with "Manganweld".

The building up of worn areas can readily be accomplished with "Stainweld" and will be desirable under the following conditions:

1. Rebuilding of worn areas (not cutting edges) on hot working or hot forging dies where hardness values of 200 or 300 Brinell are satisfactory.

2. As a base layer on which hard surfacing material such as "Manganweld" or "Abrasoweld" can be built up. The lack of tendency for under-bead cracking in welding the hard to weld steels allows "Stainweld" electrodes to be used with a minimum of preheat and in many cases without any preheat whatsoever. "Stainweld" electrodes may be deposited on hardenable alloys at temperatures 300 to 400 degrees F below those necessary for satisfactory welding with an alloy or mild steel electrode.

"Stainweld D" is generally recommended for welds requiring strength as listed above and "Stainweld A-5" and "A-7" will be satisfactory for layers of material on which hard surface electrodes are to be deposited later on.

Summary

In selecting the proper arc weld-surfacing material to resist either impact or abrasion, or various combinations of the two as found in different jobs, the preceding chart may be helpful.

It shows the comparative resistance to abrasion and to impact of Lincoln Arc Weld Surfacing Materials, as determined by tests made on two-layer deposits in the as-welded condition. The resistance to both abrasion and impact can be improved on "Toolweld 60," "Toolweld A & O," "Wearweld," "Hardweld 50" and "Hardweld 100" with proper heat treatment.

In selecting the proper surfacing material to resist corrosion, refer to the following. It lists the Surfacing Materials in their order of ability to withstand both chemical and atmospheric corrosion—the first in the list being the best:

For procedures and specifications on "Stainweld", see Lincoln Weldirectory 463.

"Stainweld A"
"Faceweld No. 12"
"Faceweld No. 1"
"Surfaceweld A"
"Abrasoweld"
"Toolweld 60"
"Toolweld A & O"
"Wearweld"
"Manganweld"
"Tungweld F"
"Tungweld C"
"Hardweld 50"
"Hardweld 100"

Special corroding media may change the order of this list.

The various Lincoln surfacing materials are discussed separately on the following pages in regard to their particular characteristics and procedures.

Instructions for use of

LINCOLN HARDSURFACING GUIDE

This chart is intended to give a comparison between types of hardsurfacing material, to help the user to choose the material best suited to his particular type of service.

The chart lists the relative characteristics of the complete line of manual hardsurfacing materials. It shows in the various columns the ability of each of the materials to resist ABRASION, metallic FRICTION, IMPACT, and CORROSION. It also gives the relative HARDNESS, DUCTILITY, and COST of depositing the material as well as the physical limitations of WELD SIZE in applying each one.

This chart is a guide to help:

(A) Select the hardsurfacing electrode best suited for a job not hardsurfaced before;

(B) Select a more suitable hardsurfacing electrode for a job where present material has not produced desired results.

Example 1

Application: **Dragline bucket tooth**

Service: **Sandy gravel with some good-sized rocks.**

Maximum wear that can be economically obtained is the goal of most hardsurfacing applications. Try to use a material that rates as high as possible in the resistance to ABRASION column unless some other characteristic shown in the other columns makes it unsuited for this particular application.

First, consider the "Tungwelds." Notice that "Tungwelds" are composed of very hard particles in a softer and less abrasion resisting matrix. While "Tungweld" is the best for resisting sliding abrasion on hard material, in sand the matrix is apt to scour out slightly and then the brittle particles are exposed. These particles are rated poor in IMPACT resistance and they may break and spall off when they encounter the rocks.

Next best in ABRASION is "Surfaceweld" shown in WELD SIZE column to be a powder that can only be applied in a thin layer, and also not rated high in IMPACT resistance. This makes it doubtful for use in this rocky soil.

The two "Facewelds" also rate very high in ABRASION, but do not rate high in IMPACT. However, "Faceweld 1" does show sufficient IMPACT rating to be considered if 2 or 3 different materials were to be tested in a field test. Since there is a chance that "Faceweld 1" has enough impact resistance to do this job, we would not like to pass up its very good wearing properties.

"Abrasoweld" is a material that is very well balanced in both ABRASION and IMPACT resistance, being much better in resistance to IMPACT than the materials that rate higher in ABRASION. Thus "Abrasoweld" is the first choice on this job, considering the added IMPACT resistance of "Manganweld" as not being necessary since the IMPACT in this application is not extreme.

Example 2

Application: **Same dragline tooth used in Example 1.**

Service: **Soil changed to clay and shale.**

The "Abrasoweld" selected in the first example is standing up well but the teeth wear only half as long as the bucket lip. With double the wear on the teeth only half the down time periods for resurfacing would be needed and both teeth and bucket could be done together.

Since the IMPACT is now negligible with the new soil conditions, go to a material higher in the ABRASION column. Choose a material such as "Faceweld 12" which could give twice the wear by controlling the size of bead applied and still be within reason in COST.

Example 3

Application: **Same dragline tooth use as in Example 1 and 2.**

Service: **Soil changed to contain large rocks.**

If the earth had been changed so that it contained many hard and large rocks and the teeth are failing due to spalling under IMPACT, move down in the ABRASION rating to a better IMPACT resisting material such as Manganweld.

From the above, it can be seen that where a dragline operates in all kinds of soils a material that is both good in ABRASION and IMPACT such as "Abrasoweld" is the best choice when in doubt as to the conditions that will be met.

By following this same type of reasoning in checking the important characteristics, a material can be chosen for any application and if, for any reason, the first choice does not prove satisfactory, it is usually a simple matter to improve the next application by choosing a material that is rated higher in the characteristic that has caused difficulty.

Where failures occur due to cracking or spalling, it usually indicates that a material higher in impact or ductility rating should be used; where normal wear alone seems too rapid, a material higher in the abrasion rating is indicated.

Many times hardsurfacing failures due to cracking or spalling may be caused by improper welding procedures rather than improper choice of hardsurfacing material. Before changing to a different hardsurfacing material, serious consideration should be given to the question of whether or not the material has been properly applied.

For almost any hardsurfacing application, very good results can be obtained if the following precautions are observed:

(1) **DO NOT APPLY HARDSURFACING MATERIAL OVER CRACKED OR POROUS AREAS.**

Remove any defective areas down to sound base metal.

(2) **PREHEAT**

Preheating to 400-500° F. improves the resistance to cracking and spalling. This minimum temperature should be maintained until welding is completed. The exception to this rule is 11-14% manganese steel which should be kept cool.

(3) **COOL SLOWLY**

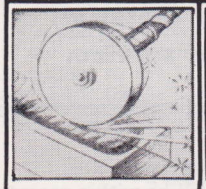
If possible, allow the finished weldment to cool under an insulating material such as lime, asbestos or sand.

(4) **DON'T APPLY MORE THAN THE RECOMMENDED NUMBER OF LAYERS.**

When more than normal build-up is required, apply intermediate layers of Hardweld or Stainweld. This will provide a good bond to the base metal and will eliminate excessively thick layers of hardsurfacing material which might otherwise spall off.

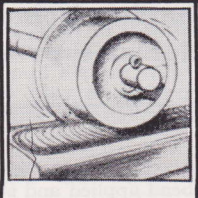
Stainweld is also an excellent choice for intermediate layers on manganese steels or for hard-to-weld steels where preheating is not practical.

RESISTANCE TO SCRATCH
ABRASION
SAND, GRAVEL, STONE, ETC.



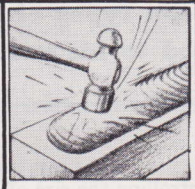
LENGTH OF BAR SHOWS RELATIVE RESISTANCE TO ABRASION

RESISTANCE TO METALLIC
FRICTION
ROLLING OR SLIDING



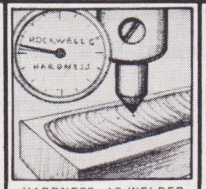
LENGTH OF BAR SHOWS RELATIVE RESISTANCE TO ROLLING FRICTION

TOUGHESS OR RESISTANCE TO
IMPACT
WITHOUT CRACKING OR SPALLING



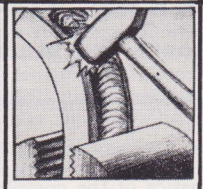
LENGTH OF BAR SHOWS RELATIVE RESISTANCE TO IMPACT

RESISTANCE TO DEFORMATION
HARDNESS



HARDNESS – AS WELDED (ROCKWELL SCALE)
30 C | 50 C | 70 C

DUCTILITY
ABILITY TO BEND WITHOUT FAILURE

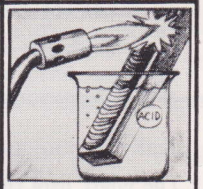


LENGTH OF BAR SHOWS RELATIVE DUCTILITY

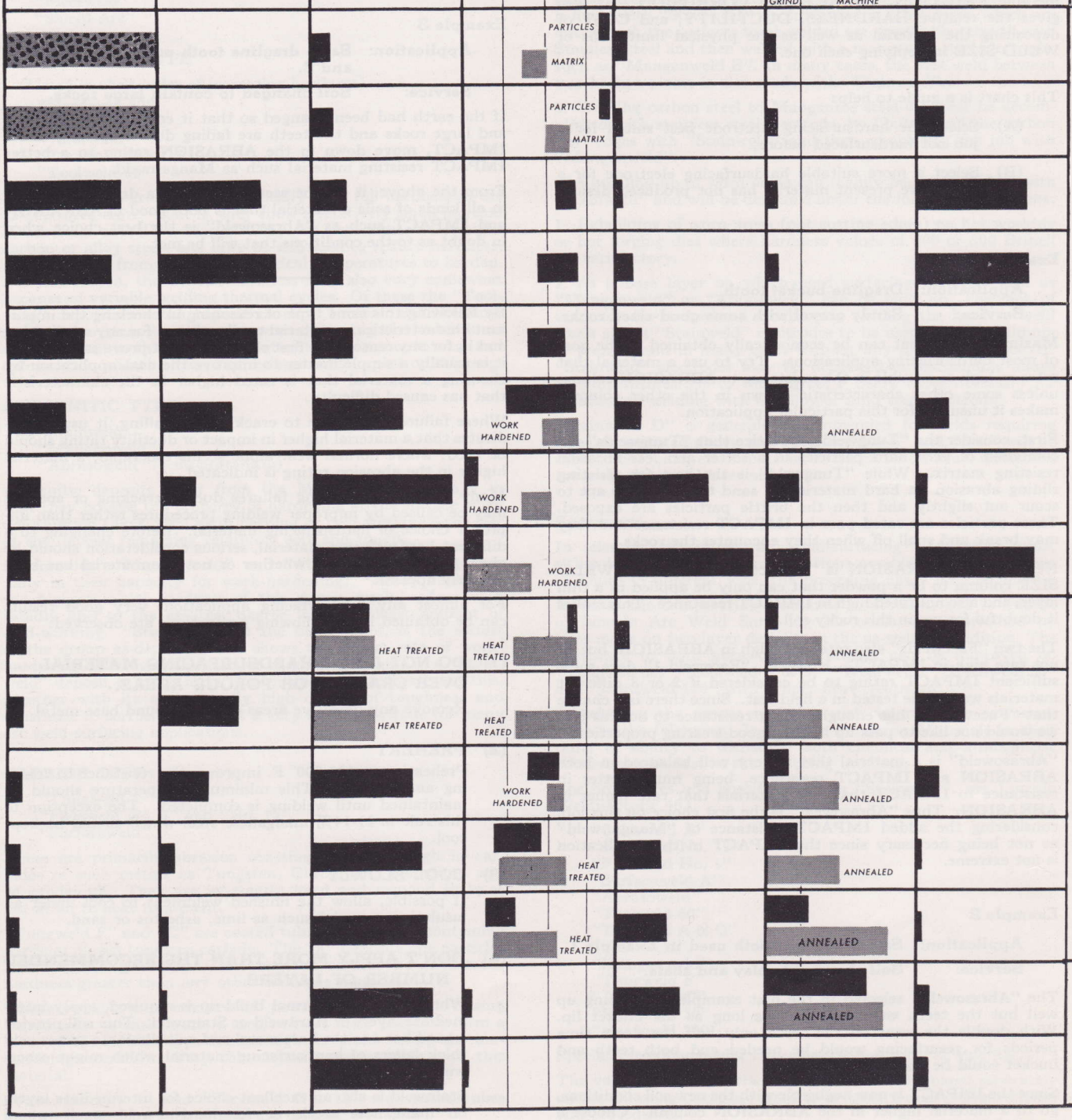
MACHINABILITY

LENGTH OF BAR SHOWS RELATIVE MACHINABILITY AS WELDED
GRIND | MACHINE →

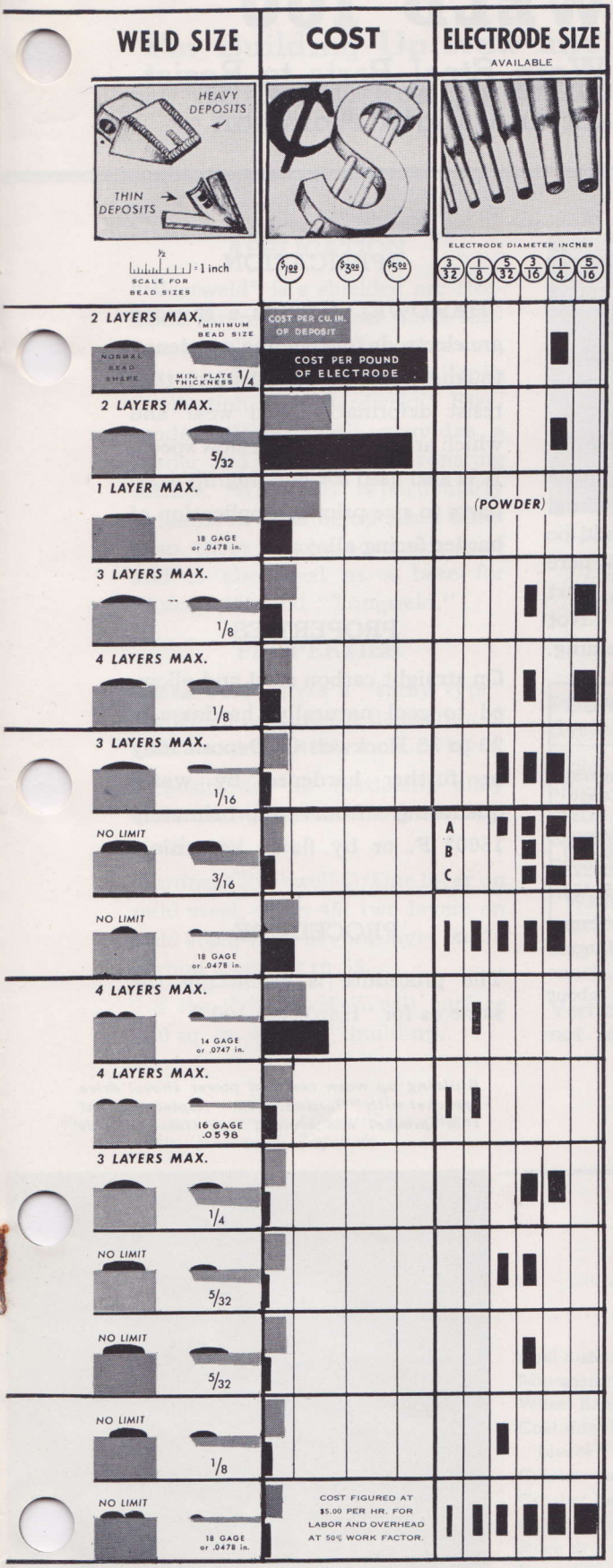
RESISTANCE TO
CORROSION
RUST, PITTING, HIGH TEMPERATURE SCALING



LENGTH OF BAR SHOWS RELATIVE RESISTANCE TO CORROSION



LINCOLN HARDSURFACING GUIDE



TUNGWELD C (CARBIDE TYPE)
WELD DEPOSIT STUDDED WITH EXTREMELY HARD PARTICLES OF TUNGSTEN CARBIDE HELD IN A RELATIVELY TOUGH ALLOY MATRIX. THIS MATERIAL IS RECOGNIZED AS THE ULTIMATE IN RESISTANCE TO ABRASION. WHEN THE SURFACE OF THE DEPOSIT IS SUBJECTED TO ABRASIVE WEAR, THE IRON ALLOY MATRIX TENDS TO WEAR AWAY LEAVING TOOTH LIKE PARTICLES OF TUNGSTEN CARBIDE.
DC (—)

TUNGWELD F (CARBIDE TYPE)
WELD DEPOSIT HAVING VERY FINE AND EVENLY DISTRIBUTED PARTICLES OF TUNGSTEN CARBIDE. THESE PARTICLES ARE SMALL ENOUGH AND NEAR ENOUGH TOGETHER SO THAT THEY WILL NOT BE UNDERMINED WHEN THE MATRIX IS EXPOSED TO SEVERE ABRASION OR WEAR. THIS TYPE IS USED TO PRODUCE A THIN DEPOSIT OR ONE THAT WILL WEAR TO A SHARPER OR THINNER EDGE THAN WELDS MADE WITH THE COARSE TUNGSTEN CARBIDE TYPE.
DC (+) OR AC

SURFACEWELD (CARBIDE TYPE)
WELD DEPOSIT CONSISTS OF MICROSCOPIC CHROMIUM CARBIDE CRYSTALS HELD IN A FAIRLY HARD MATRIX. BOTH THE CARBIDE CRYSTALS AND THE MATRIX MATERIAL HAVE HIGH ABRASION RESISTANCE. THESE DEPOSITS HAVE RELATIVELY LOW IMPACT STRENGTH. SURFACEWELD COMES IN POWDER FORM FOR SINGLE CARBON OR ARC TORCH APPLICATION.
SINGLE CARBON DC (—) OR AC
ARC TORCH AC

FACEWELD 12 (CARBIDE TYPE)
WELD DEPOSIT CONSISTS OF MICROSCOPIC CHROMIUM CARBIDE CRYSTALS HELD IN A FAIRLY HARD MATRIX. BOTH THE CARBIDE CRYSTALS AND THE MATRIX MATERIAL HAVE HIGH ABRASION RESISTANCE.
DC (+) OR AC

FACEWELD 1 (CARBIDE TYPE)
WELD DEPOSIT CONSISTS OF MICROSCOPIC CHROMIUM CARBIDE CRYSTALS HELD IN A TOUGH HARD MATRIX. THIS MATERIAL HAS GOOD ABRASION RESISTANCE AND MODERATELY GOOD TOUGHNESS.
DC (+) OR AC

ABRASOWELD (SEMI-AUSTENITIC TYPE)
HIGH CARBON CHROMIUM ALLOY MATERIAL WHICH IS SEMI-AUSTENITIC IN THE AS WELDED CONDITION. DEPOSIT HAS HIGH HARDNESS, GOOD ABRASION RESISTANCE, MODERATE TOUGHNESS AND EXCELLENT HOT FORGING PROPERTIES.
DC (+) OR AC

MANGANWELD A, B & C (AUSTENITIC TYPE)
WELD DEPOSIT IS 11 TO 14% MANGANESE FULLY AUSTENITIC TYPE WHICH IS EXTREMELY TOUGH AND WHICH DEVELOPS MAXIMUM SURFACE HARDNESS BY PEENING OR ANY FORM OF COLD WORKING. THIS MATERIAL IS RECOGNIZED AS BEING THE ULTIMATE IN TOUGHNESS.
MANGANWELD A DC (+) OR AC
MANGANWELD B DC (+) OR (—)
MANGANWELD C DC (+)

STAINWELD (AUSTENITIC TYPE)
AUSTENITIC CHROME NICKEL ALLOYS FROM 18% CHROME—8% NICKEL TO 25% CHROME —20% NICKEL. THE DEPOSIT HAS RELATIVELY LOW ABRASION RESISTANCE AS WELDED BUT STAINLESS STEELS WILL WORK HARDEN APPRECIABLY AND TOGETHER WITH THEIR HIGH DEGREE OF TOUGHNESS AND RESISTANCE TO CORROSION BECOME A GOOD CHOICE FOR MANY SURFACING APPLICATIONS.
DC (+)

TOOLWELD 60 (MARTENSITIC TYPE)
WELD DEPOSIT IS OF THE HIGH SPEED MOLYBDENUM TYPE TOOL STEEL. DEPOSITS ARE USUALLY SATISFACTORY AS WELDED, OR THE DEPOSIT MAY BE TEMPERED OR GIVEN THE STANDARD HIGH SPEED STEEL HEAT TREATMENT. THE DEPOSIT MAINTAINS FULL HARDNESS AT TEMPERATURES UP TO 1000° F.
DC (+)

TOOLWELD A & O (MARTENSITIC TYPE)
WELD DEPOSIT IS A 5% CHROME TOOL STEEL TYPE. THIS TYPE IS VERY VERSATILE, FOR IT HAS GOOD PROPERTIES AS WELDED AND THESE PROPERTIES CAN BE IMPROVED BY HEAT TREATING. THIS TYPE IS EXTREMELY WELL SUITED FOR MOST TOOL AND DIE WORK EXCEPT FOR APPLICATIONS WHERE A HIGH SPEED TYPE DEPOSIT (HIGH TEMPERATURE HARDNESS) IS REQUIRED.
DC (—) OR AC

WEARWELD (MARTENSITIC TYPE)
LOW CARBON CHROME MANGANESE ALLOY PARTLY MARTENSITIC & FERRITIC IN THE AS WELDED CONDITION. THE DEPOSIT IS UNIFORMLY HARD AND MODERATELY TOUGH.
DC (+) OR AC

HARDWELD 100 (MARTENSITIC TYPE)
WELD DEPOSIT IS A NON-ALLOYED MEDIUM CARBON TYPE. THE CARBON CONTENT USUALLY RUNS BETWEEN .60 AND .80%. THE DEPOSIT MAY BE HEAT TREATED TO GIVE PHYSICAL PROPERTIES COMPARABLE TO MEDIUM CARBON STEEL. DEPOSITS MAY ALSO BE HOT FORGED. ANNEALING THE DEPOSITS WILL PERMIT GOOD MACHINABILITY AND SUBSEQUENT HEAT TREATMENT WILL RESTORE IT TO THE DESIRED HARDNESS.
DC (+) OR AC

HARDWELD 50 (MARTENSITIC TYPE)
WELD DEPOSIT IS A NON-ALLOYED MEDIUM CARBON TYPE WITH CARBON CONTENT RUNNING AROUND .40%. DEPOSITS ARE USUALLY MACHINABLE IN THE AS WELDED CONDITION. DEPOSITS MAY BE HOT FORGED. ADDITIONAL HARDNESS CAN BE OBTAINED BY HEAT TREATMENT.
DC (+) OR AC

SHIELD-ARC 90CM (FERRITIC TYPE)
LOW CARBON FERRITIC TYPE DEPOSIT WITH 1.25% CHROME AND .5% MOLYBDENUM. USED PRIMARILY FOR PRELIMINARY BUILD UP BEFORE HARD-FACING OR FOR APPLICATIONS REQUIRING ONLY SLIGHTLY BETTER WEAR PROPERTIES THAN MILD STEEL OR WHERE GOOD MACHINABILITY IS IMPORTANT.
DC (+)

FLEETWELD (FERRITIC TYPE)
CONVENTIONAL LOW CARBON FERRITIC TYPE WELD DEPOSIT HAVING NO PARTICULAR APPLICATION IN THE HARD SURFACING FIELD EXCEPT POSSIBLY FOR THE PURPOSE OF PRELIMINARY BUILD UP. THIS TYPE IS INCLUDED PRIMARILY FOR THE PURPOSE OF COMPARISON.
DC AND AC

Coating—Gray-Green
Code—(E) Brown
(S) White

Coating—Gray-Green
Code—(E) Brown
(S) Red

HARDWELD 50
HARDWELD 100

For Building Up Worn Steel Parts to Resist Moderate Impact and Light Abrasion

APPLICATION

"HARDWELD 100" is a shielded arc, high-carbon electrode for building up worn steel parts to produce a dense, tough surface of moderate hardness to resist shock and abrasion.

It is available with either extruded (Hardweld 100) extruded coating 5/32", 3/16" (Hardweld 100—DIP) 5/32", 3/16" and 1/4".

PROPERTIES

Contains approximately .75% carbon. Hardness of deposit on straight carbon steel when allowed to cool naturally: 20 to 45 Rockwell C. Exact hardness depends on rate of cooling and carbon content of steel welded.

Can be hot forged. Cannot be machined unless cooled very slowly or annealed. Grind to shape, if shaping is necessary.

PROCEDURE

POLARITY—D.C. electrode positive; or electrode negative; or A.C. Electrode positive gives a slightly harder deposit. Electrode negative gives a higher deposition rate.

Deposit wide or narrow beads as desired. Clean each bead before depositing next. Peening the completed bead will harden the deposit somewhat.

Can be used for vertical welding, but for best results work should be as near flat as possible. Where vertical welding is required, start at bottom and weld up. Not recommended for overhead welding.

POSITION: FLAT				
Hardweld 50		Hardweld 100		Amperage Range
Dia.	Lgth.	Dia.	Lgth.	
.....	.....	5/32"	14"	100–150
3/16"	14"	3/16"	14"	150–225
.....	.....	1/4"	14"	225–350

"Hardweld" is packed in standard Lincoln containers of 50 lbs. each.

0.44 lb. "Hardweld" will deposit about 1 cu. in.

APPLICATION

"HARDWELD 50" is a shielded arc electrode for building up dense, tough, medium carbon deposits that resist deformation and wear and which are machinable at slow speed. It is also used for building up worn parts to size prior to application of harder facing alloys.

PROPERTIES

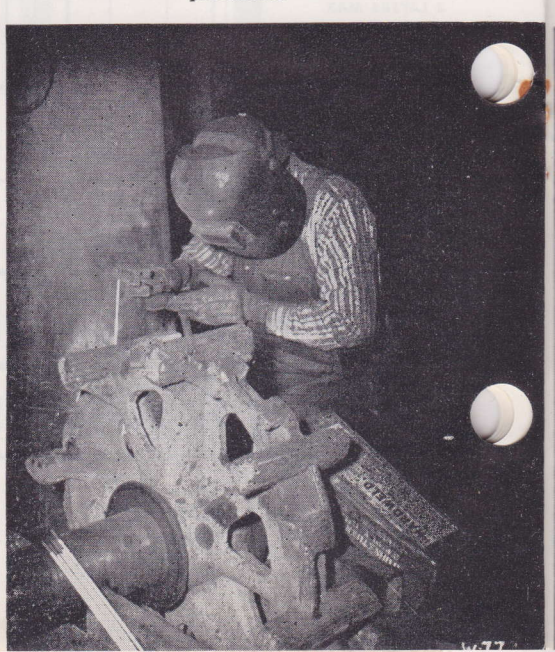
On straight carbon steel and allowed to cool naturally, hardness is 20 to 35 Rockwell C. Deposit may be further hardened by water quenching from approximately 1500° F. or by flame hardening.

PROCEDURE

The procedure is essentially the same as for "Hardweld 100."

Worn hoist and drag chain links for dragline bucket built up with "Hardweld 100."

Building up worn teeth of power shovel drive sprocket with "Hardweld 100." Replacement of this sprocket was avoided four times by this procedure.



TYPICAL APPLICATIONS

Pump housings	Well drilling tools
Tractor grousers	Pulverizer hammers
Mine car wheels	Crusher rolls
Shafts	Gear teeth
Dies	Punches
Sprockets	Wobblers
Crane wheels	Dredging spuds
Tractor shoes	Mixer blades
Tractor rollers	Trip dogs

WEARWELD

For Building Up New and Worn Steel Parts to Resist Rolling or Sliding Abrasion

Coating—Dark Gray

Code—(none)

APPLICATION

"Wearweld" is a shielded arc electrode for refacing steel parts subject to rolling or sliding abrasion, batter and impact. While similar in application to "Hardweld" Electrode, "Wearweld" provides a harder and more abrasion-resisting surface. "Wearweld" is particularly valuable in building up steels other than those of the austenitic type and is also used as a base for "Faceweld" and "Tungweld."

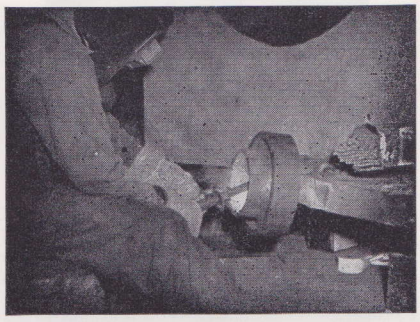
PROPERTIES

"Wearweld" gives a "spray type" arc which permits the deposition of a thin and relatively smooth layer.

Deposits are air hardening alloy steel with unusual hardness and toughness.

Hardness Rockwell C: One layer on mild steel, 40 to 45; two layers on mild steel, 48 to 52; one layer on .70 carbon steel, 50 to 55.

1.8 lbs. "Wearweld" will surface 100 sq. in. with $\frac{1}{32}$" build-up.



Building up worn face and inside seal of a steel mill pump ring by adding a 1/4-inch surface with "Wearweld" Electrode.

PROCEDURE

POLARITY—D.C., electrode positive.

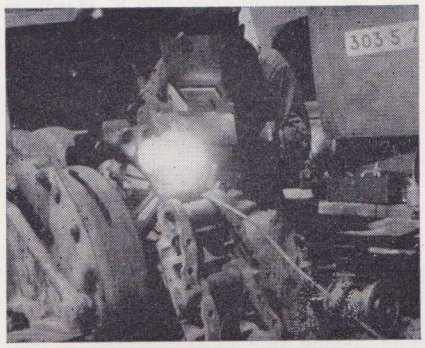
Hold fairly close arc but do not allow coating to touch molten metal. A weaving motion of the electrode should be used where possible.

"Wearweld," as deposited, is not machinable. When shaping is necessary, grind to shape or anneal and machine.

Vertical or overhead welding is not recommended.

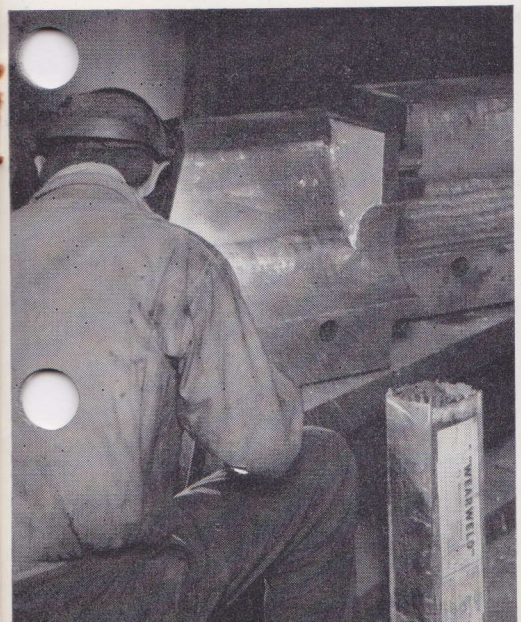
FLAT		
Rod Size		Amperage Range
Dia.	Length	
3/16"	18"	110–275
1/4"	18"	150–400

"Wearweld" is packed in standard Lincoln containers of 50 lbs. each.



Building up the worn sprocket teeth of a power shovel with "Wearweld."

Reclaiming magazines for briquette machine with "Wearweld" Electrode.



Raker bars, subject to batter and abrasion, are built up with "Wearweld" Electrode.

TYPICAL APPLICATIONS

- Coal mine car wheels
- Mine rails
- Wheel flanges
- Coal dust blower blades
- Crusher pads
- Crusher hammers
- Crane wheels
- Rock drills
- Caterpillar treads
- Forming dies
- Cams
- Craneways
- Transfer tables
- Bin steel surfacing
- Conveyor buckets
- Dredge pipe
- Skip guides
- Caterpillar drive sprockets
- Caterpillar track links

Coating—Black

Code—(none)

ABRASOWELD

For Building Up New and Worn Parts to Resist Severe Impact and Moderately Severe Abrasion

APPLICATION

"Abrasoweld" is a shielded arc electrode for building up straight carbon steel, low-alloy steel or high manganese steel with a deposit which resists severe abrasion, pronounced battering and impact.

PROPERTIES OF DEPOSITED METAL

"Abrasoweld" deposits an abrasion resisting alloy of semi-austenitic type. The hardness will normally be within the range shown below:

Single layer	24-53 R. C.
Double layer	28-53 R. C.
Multiple layer (no dilution)	28-55 R. C.

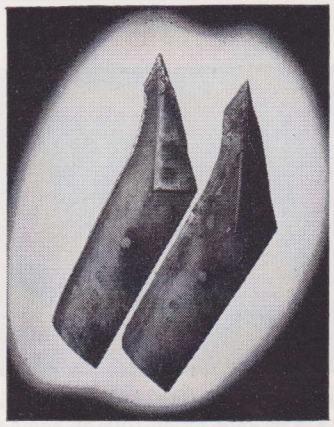
In general, preheat or interbead temperatures up to 200°F will produce the low hardness readings whereas temperatures of around 600° will produce high hardness readings. If maximum abrasion resistance is desired, do not allow preheat or interbead temperatures above 600°F. Hardness is not always a measure of wear or abrasion resistance of the deposit. "Abrasoweld" can be forged hot without materially altering its physical properties.

The properties of "Abrasoweld" deposits usually are dependent upon two variables:

1. Analysis of the deposit.
2. Cooling rate of the deposit.

The analysis of the single layer deposit is influenced by the following factors: welding speed, bead size, bead shape, welding current, electrode size, polarity, arc voltage, and position of welding.

The cooling rate of the deposit is controlled by the summation of the effects of mass or section dimension and heat input.



Left: Plow share with welded-on tip surfaced along edge with bead of "Abrasoweld." Right: same share after hot-forging—ready for service.

PROCEDURE

Polarity—D.C. positive or A.C. for maximum density and toughness.

D.C. negative for increased deposition rate.

Hold fairly close arc but do not allow coating to touch the molten metal.

Cooling stresses should be minimized by either peening each bead as deposited or by preheating and maintaining an interbead temperature of 200-300°F.

For straight carbon steel or low alloy steel, build up largely with "Hardweld" or "LH-70" and finish with two layers of "Abrasoweld." Avoid thick multi-layer deposits.

In applications requiring a thicker deposit of "Abrasoweld", keep the work hot, or apply a layer of "Stainweld A" under each two layers of "Abrasoweld", peening each layer as deposited.

On high manganese steel, build up to within two layers with "Manganweld" and finish up with "Abrasoweld". In either case, peen each layer as deposited to relieve cooling stresses.

"Abrasoweld" deposits are not machineable. Grind to shape if shaping is necessary. More uniform hardness may be obtained by weaving approximately 3/4" wide beads rather than stringer beads.

If for some reason the deposit must be machined, heat the deposit to between 1370° and 1390°, hold one hour for each inch of thickness and air cool. For maximum machineability, heat the deposit to between 1600°F and 1650°F, hold one hour for each inch of thickness and furnace cool at the rate of 50° maximum per hour down to 1200°F and then either air or furnace cool. The deposit may be made abrasion resistant again by heating to between 1425°F to 1475°F, quenching, and drawing at 400°F.

Rod Size		Amperage Range
Dia.	Length	
5/32"	14"	75–200
3/16"	14"	110–270
1/4"	14"	160–400

Increase recommended currents 10% for A.C.

"Abrasoweld" is packed in standard Lincoln containers of 50 lbs. each.

To deposit 1 cu. inch, 0.38 pounds of electrode is required.

Dragline "crowfoot" built up at worn parts with "Fleetweld 7" and hard-faced with "Abrasoweld" at a total cost of $4.50. Saves $7.00.

Dipper tooth for power shovel. Built up with "Manganweld" and hard-faced with "Abrasoweld."

TYPICAL APPLICATIONS

Dipper teeth
Tractor grousers
Shovel tracks
Shovel drive sprockets
Dipper lips
Rock crusher hammers
Sand pump impellers
Dredge cutter teeth
Scraper blades
Charging rams
Screw flights
Plow shares
Scarifier teeth
Truck chains
Pump housings
Rock crushers
Coal mining cutters
Conveyor buckets
Conveyor rolls
Gears
Crusher mantles
Pulverizer plows
Mill hammers

SURFACEWELD

For Hard-Surfacing to Resist Severe Abrasion

Coating—(Powder)

Code—(none)

APPLICATION

"Surfaceweld" is a fine-grained alloyed powder which is applied with the carbon arc torch to produce a smooth, dense, abrasion-resisting surface of the chromium carbide type. It can be applied in a very thin layer if desired, and is particularly useful for surfacing thin steel parts.

PROPERTIES

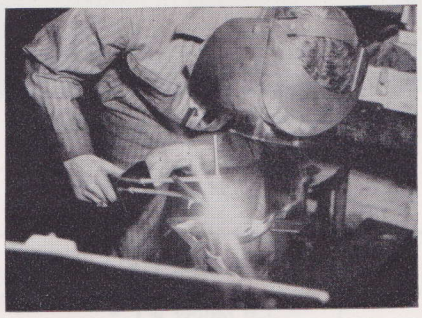
Hardness of deposit (depending upon amount of admixture with base metal) is approximately 54-61 Rockwell C for one layer and 57-63 for multiple layers. Deposit develops full hardness in as deposited condition. Maintains its hardness at high temperatures and resists scaling at high temperatures. Corrosion resistance is comparable to that of stainless steel. Resistance to abrasion is excellent. Deposit as thin as .020" can be applied to light gauge metal.

PROCEDURE

Spread powder evenly over area to be surfaced and to a depth of two or three times the desired thickness of deposit. On curved or irregular surfaces where powder does not stay in place, use "Surfaceweld" as a thick paste by mixing with water.

One-pound can of "Surfaceweld"

For best results, the applied paste should be dried before using. For most applications, the carbon arc torch is the preferred heat source for fusing the "Surfaceweld" powder. A single carbon arc may be used when torch is not available or for depositing "Surfaceweld" on thick base metal.

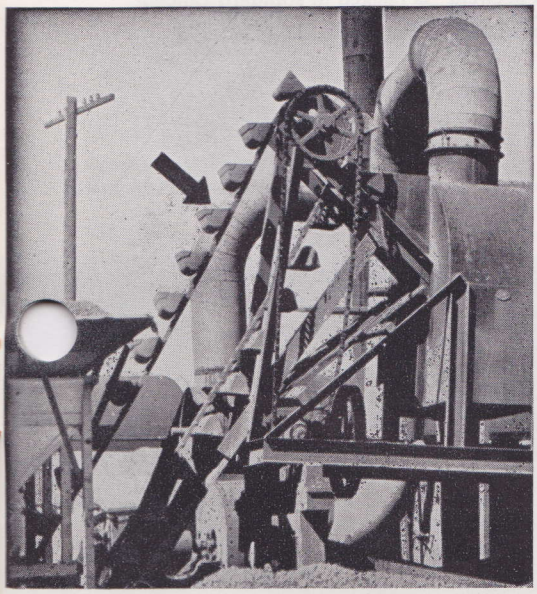


Applying "Surfaceweld" to edge of a cultivator sweep.

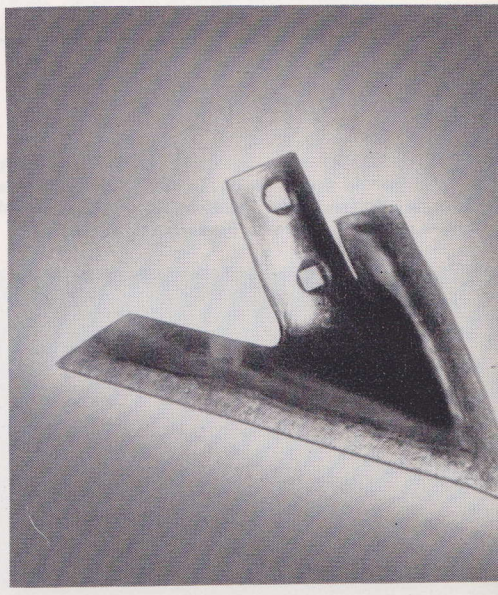
Thickness of Base Metal	Approximate Current Amps	
	Arc Torch	Carbon Electrode
	AC	DC(—) or AC
1/16"	50– 60	
1/8"	70– 80	100
1/4"	90–100	190
over 1/4"	110–125	200–250

Base metal must be hot before "Surfaceweld" will flow to produce a smooth deposit. After pre-heating the base metal at the starting end of the weld, melt the "Surfaceweld" powder with the arc flame using a weaving motion. Adjust current and rate of travel to obtain fusion of the powder into a smooth bead. Too much heat will cause excessive dilution of the deposit by base metal. Often excessive dilution or burn-thru may be minimized by positioning work so that the welding proceeds down hill at about 3°.

One pound of "Surfaceweld" will surface about 100 sq. inches with 1/32" built-up.



Lips of buckets on gravel plant conveyors are hard-surfaced with "Surfaceweld."



"Surfaceweld" on edge of cultivator sweep showing thinness of deposit.

TYPICAL APPLICATIONS

- Plow shares
- Cultivator sweeps
- Bucket Lips
- Bean knives
- Mixing blades
- Hoes
- Shovels and spades
- Harrow discs
- Cement block formers
- Augers
- Cultivator shovels
- Feed mill hammers
- Tiller tines

FOR PROCEDURES AND SPECIFICATIONS ON LINCOLN AUTOMATIC HARDSURFACING WRITE FOR WELDIRECTORY 468

Coating—Slate

Code—(E) Yellow

FACEWELD 1

For Hard Surfacing New and Worn Parts to Resist Severe Abrasion and Moderate Impact

APPLICATION

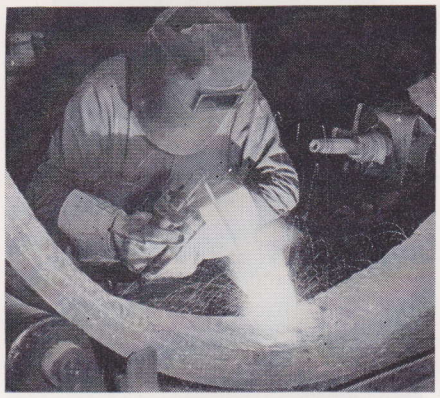
"Faceweld 1" is a coated tubular electrode. Used for hard-surfacing carbon, alloy, or manganese steel to resist metallic or non-metallic abrasion and impact even at elevated temperatures and in the presence of corrosive atmospheres.

PROPERTIES OF DEPOSITED METAL

"Faceweld 1" forms a weld deposit consisting of microscopic chromium carbide crystals in a tough, hard matrix. This material has good abrasion resistance and moderately good toughness.

Deposits are non-machinable. When required, finish by grinding.

Corrosion resistance is comparable generally to stainless steel.



Die ring worn by moderate impact and severe abrasion is hardsurfaced with "Faceweld 1".

When Deposited on Mild Steel	"Faceweld 1"
One Layer Hardness	40-52 R.C.*
Multilayer Hardness	50-58 R.C.
Multilayer at 1000°F. Hardness	Average 38 R.C.
Multilayer at 1500°F. Hardness	Average 30 R.C.
Electrode to Surface 100 sq. in.— 1/16" Build-up	2.2 Lbs.

*Rockwell C.

PROCEDURE

POLARITY—For D.C. (electrode positive) or A.C.

Hold fairly short arc. Weave beads full width of deposit if possible.

Preheat to eliminate any tendency for cross checking. For a deposit of 3 or more layers use a high preheat and cool work very slowly.

FLAT		
Rod Size		Amperage Range
Dia.	Lgth.	
3/16"	14"	60-150
5/16"	14"	145-350

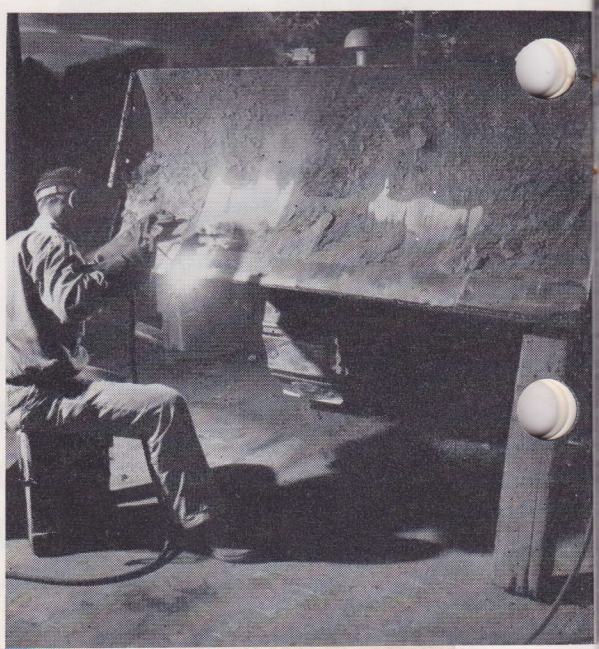
"Faceweld" is packed in standard Lincoln 10 lb. containers.

Manganese steel rock crusher bells, subject to severe abrasion, are reclaimed with "Faceweld 1."

TYPICAL APPLICATIONS

- Scarifier teeth
- Grader blades
- Cement mill parts
- Coke machinery parts
- Brick plant parts
- Bradley and Griffin rings
- Pug mill paddles
- Wire feed rolls
- Conveyor sleeves
- Gyratory crusher mantles
- Shovel bucket lips
- Pulverizer jaws
- Crusher mill plates
- Crusher rolls

Worn cutting edge of bulldozer blade is built up with impact and abrasion resisting "Faceweld 1".



FACEWELD 12

For Hard Surfacing New and Worn Parts to Resist Severe Abrasion

Coating—Slate

Code—(E) Pink

APPLICATION

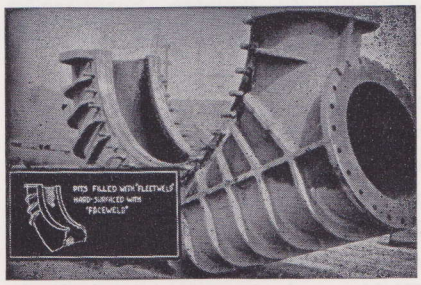
"Faceweld No. 12" is a coated tubular electrode. Used for hard-surfacing carbon, alloy, or manganese steel to resist metallic or non-metallic abrasion even at elevated temperatures and in the presence of corrosive atmospheres.

PROPERTIES OF DEPOSITED METAL

"Faceweld 12" forms a weld deposit consisting of microscopic chromium carbide crystals held in a fairly hard matrix. Both the carbide crystals and the matrix material have high abrasion resistance.

Deposits are non-machinable. When required, finish by grinding.

Corrosion resistance is comparable generally to stainless steel.



Dredge pumps, worn by sand abrasion, are reclaimed by building up the worn areas with "Fleetweld" and then hard-surfacing with "Faceweld."

When Deposited on Mild Steel	"Faceweld No. 12"
One Layer Hardness	45-55 R.C.*
Multilayer Hardness	55-64 R.C.
Multilayer at 1000°F. Hardness	Average 49 R.C.
Multilayer at 1500°F. Hardness	Average 38 R.C.
Electrode to Surface 100 sq. in.— 1/16" Build-up	2.2 Lbs.

*Rockwell C.

PROCEDURE

POLARITY—For D.C. (electrode positive) or A.C.

Hold fairly short arc. Weave beads full width of deposit if possible.

Preheat to eliminate any tendency for cross checking. For a deposit of 3 or more layers use a high preheat and cool work very slowly.

FLAT		
Rod Size		Amperage Range
Dia.	Lgth.	
3/16"	14"	60–150
5/16"	14"	145–350

"Faceweld" is packed in standard Lincoln 10 lb. containers.

Crusher roll must withstand severe abrasion. Outside diameter is hardsurfaced with multiple layers "Faceweld 12".

Aggregate, falling five feet onto this chute, wears the metal down due to severe abrasion. The plate is hard-faced with "Faceweld 12."

TYPICAL APPLICATIONS

- Screw conveyors
- Scarifier teeth
- Cement mill parts
- Coke machinery parts
- Brick plant parts
- Bradley and Griffin rings
- Conveyor sleeves
- Shovel bucket lips
- Dredge pump casings

Coating—Slate

Code—Light Gray

TOOLWELD 60

For Making Metal Cutting Edges

APPLICATION

"Toolweld 60" is a shielded arc electrode which deposits high speed tool steel.

It is used for:

Alteration or reconditioning tools or parts made of high speed tool steel.

The fabrication of high speed steel tools by using a carbon or alloy steel base and depositing high speed tool steel on the wearing surface or edge.

Surfacing equipment requiring special wear resisting properties.

PROPERTIES OF DEPOSITED METAL

Weld metal equivalent to high speed tool steel. Although the weld metal, as deposited without heat treatment, has a hardness of between 60 and 65 Rockwell C, the degree of hardness will vary somewhat depending upon the admixture of base metal with the weld deposit. In general, hardness is increased by permitting deposit to cool slowly and by depositing additional beads. With two beads, which largely eliminate admixture of base metal, hardness will be maximum. Deposit retains its hardness at relatively high temperature (approximately 1000° F.). Welds can be heat treated similarly to high speed steel. Deposit is free from porosity.

PROCEDURE

POLARITY—D.C., electrode positive. Where only one bead can be used, currents should be low to keep down the admixture of base metal. Beads should be laid with a weaving motion to insure minimum porosity. After each bead, remove all slag before proceeding to next bead. On vertical surfaces, best results are obtained if welded from bottom up.

Exact amperage and arc length depend upon the mass of the parts being surfaced, thickness and hardness of bead desired, etc.

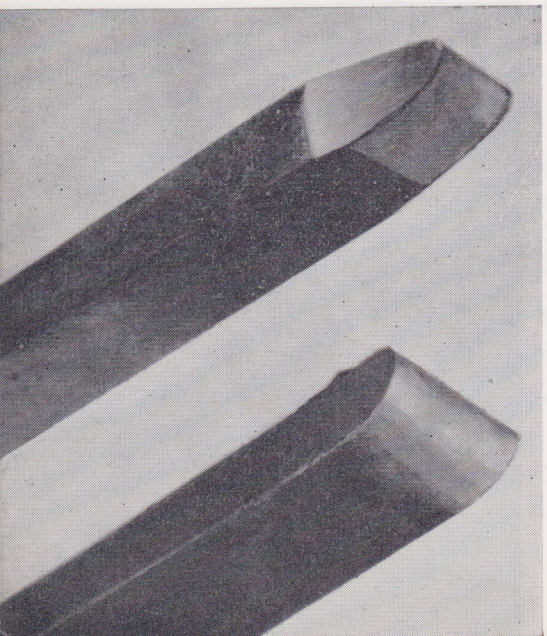
FLAT		
Rod Size		Amperage Range
Dia.	Length	
1/8"	13"	65–100

"Toolweld 60" is packed in standard Lincoln containers of 10 lbs. each.

To deposit 1 cu. in. 0.42 lbs. electrode is required.

Detailed instructions for heat treating "Toolweld 60" deposits will be furnished on request.

Shank of this lathe tool is mild steel. "Toolweld 60" is applied to cutting edge. Upper view is after dressing.



TYPICAL APPLICATIONS

Lathe tools

Lathe centers

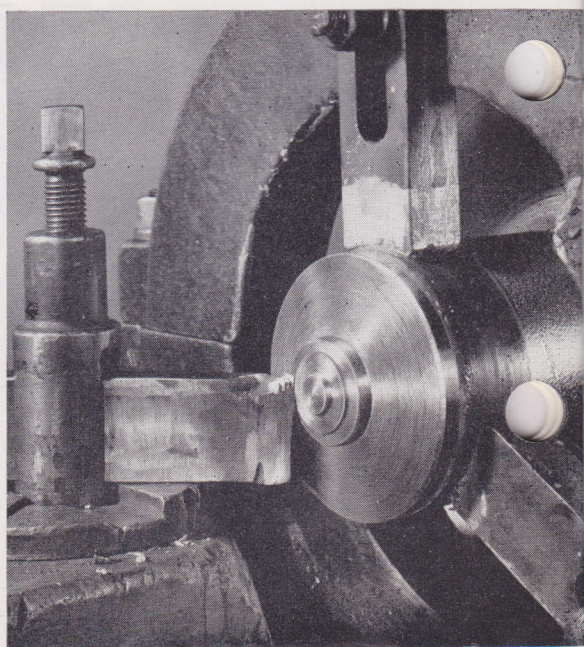
Shear blades for hot work

Broaches

Tools for turning steel mill rolls

Forming cutters

Lathe cutter in steel mill maintenance shop, built up with "Toolweld 60", machining end of heavy steel bar.



TOOLWELD A&O

Produces and Air and Oil Quenched Tool Steel Deposit

Coating—Slate

Code—(none)

APPLICATION

"Toolweld A & O" (A & O indicating air and oil hardening) is a shielded arc electrode which produces a dense deposit of high tensile strength that is resistant to metal-to-metal wear, will hold an edge and will resist deformation and failure under impact.

"Toolweld A & O" is used:

For the alteration and repair of air and oil hardening dies, punches, rolls, shears and other metal working, forming and cutting tools.

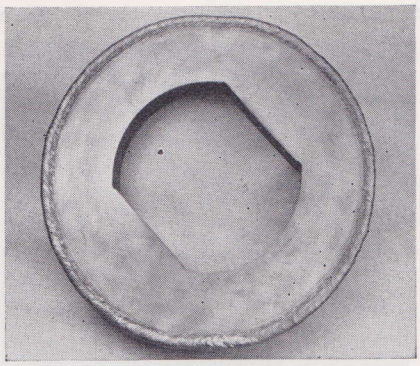
For the fabrication of composite tools—carbon steel base with surfaces or edges built-up with "Toolweld A & O" to have tool steel at the points of wear. Metal working, metal forming and metal cutting tools are economically manufactured in this manner.

For high impact service, such as is required for metal-to-metal impact (the working surface of air drill pistons).

Note: When High Speed Steel properties are required, "Toolweld 60" is used.

PROPERTIES

"Toolweld A & O" deposits tool and die steel of the 5% chrome type which can be used in the as-welded condition*, or hardened by air-cooling or by oil quenching. This is used for depositing tool steel wearing surfaces, repair of tools and dies, and fabricating of composite dies.



The cutting edge of this punch is built up with "Toolweld A&O" and ground to size. Tool life is increased several times.

Hardness as deposited is 58 to 65 Rockwell C. Deposit may be annealed at 1550° F.-1600° F. Deposit has a very wide hardening temperature range, which allows its use in repairing a variety of tool steels.

*If the service involves severe impact, deposit should be tempered. 1025°F will give maximum combination of hardness and toughness.

PROCEDURE

POLARITY—D.C., electrode negative, or A.C.

On large hardened tools and dies, preheat and interpass temperature of 900°F.-1000°F. is recommended wherever possible. When repairs are being made on hardened parts which are not to be reheat treated, preheat and interpass temperature should be as high as possible without softening the base metal.

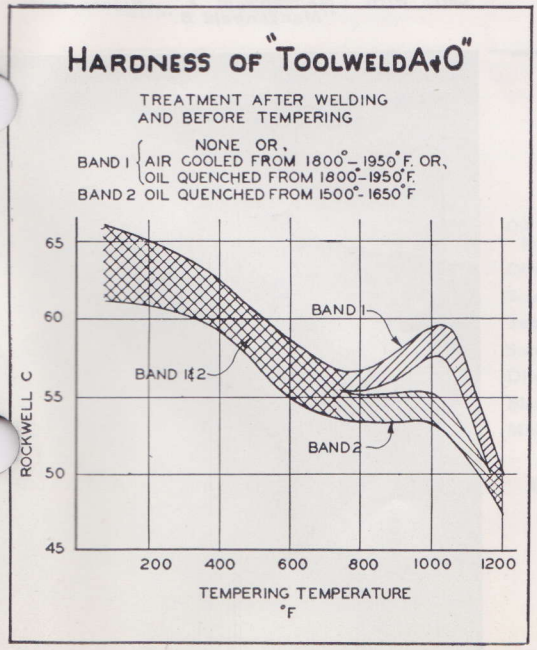
On parts that are not hardened, preheat and interpass temperature of 400-500°F. is recommended.

When the deposit is to be heat treated by tempering only, allow work to cool to room temperature so that the weld deposit will transform to martensite before tempering.

To deposit 1 cu. in. 0.42 lbs. electrodes is required.

Rod Size		Amperage Range
Dia.	Length	
3/32"	12"	40– 85
1/8"	14"	65–130

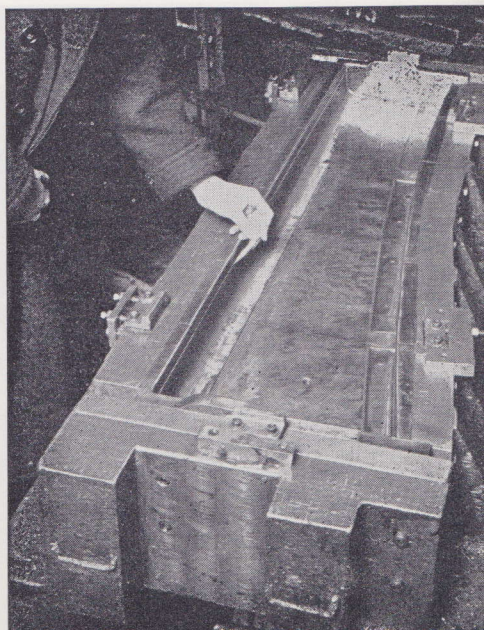
Standard Container: 10 lbs.



TYPICAL APPLICATIONS

Forming dies	Shearing dies
Punching dies	Punches
Paper cutting knives	Punch press dogs
Sewage scraper blades	Slag cleaning tools
Skelp hooks	Dogs on ingot tongs
Clutch parts	Spot weld flash trimmer
Guides	Molds
Shredder knives	Woodworking tools
Chuck jaws	Axes

After the cutting edge of this stamping die was built up with "Toolweld A&O," it stamped out 40,000 parts—said to be exceptional service.



Coating—Gray

Code—(E) Orange
(S) Red

Coating—(Tube)

Code—(none)

Coating—(Bare)

Code—(none)

MANGANWELD A
MANGANWELD B
MANGANWELD C

For Building Up High Manganese Steel to Resist Moderate Abrasion and Extremely Severe Impact

APPLICATION

"Manganweld" is an electrode for reclaiming worn austenitic manganese steel parts containing 11% to 14% manganese. It is generally recommended for flat work only.

TYPES

"MANGANWELD A" is a shielded arc, extruded coating electrode.
"MANGANWELD B" is tube type electrode having no coating.
"MANGANWELD C" is a bare, solid wire type of electrode.
All three electrodes produce a 11.0% to 14.0% manganese deposit with molybdenum and copper.

PROPERTIES

In general, "Manganweld A" will give flatter bead than either "Manganweld "B" or "C". Melts uniformly with minimum spatter and boiling in crater. Deposits air-toughening, remaining in austenitic state and retaining carbides in solution even on air cooling. Abrasion and impact resistance equal to heat-treated cast manganese steel.

Hardness Rockwell C

As deposited..... 5 to 10
Cold worked.....45 to 50

ELECTRODE TO DEPOSIT 1 CU. IN.

"Manganweld A".....0.42 Lb.
"Manganweld B"..... .35 Lb.
"Manganweld C"..... .35 Lb.

PROCEDURE

POLARITY—"MANGANWELD A"—D.C. electrode positive or A.C.

"MANGANWELD B"—D.C. positive for best arc characteristics—D.C. negative for fastest deposition rate.

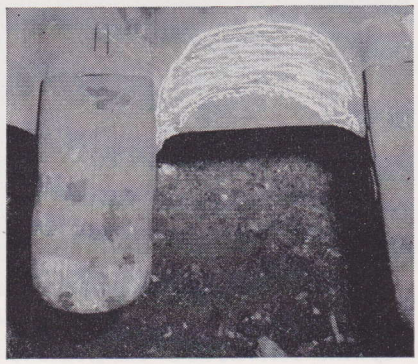
"MANGANWELD C"—D.C. electrode positive.

Use "Manganweld" for resurfacing and building up high-manganese steel. For welding up cracks in high manganese steel, for welding parts of high manganese steel together, or for welding a part to mild rolled steel, use "Stainweld A-5." Then if an abrasion-resisting surface is required, apply top beads with "Manganweld."

First remove all rust, grease, spongy or defective metal from work. Use lowest heat possible. Allow work to cool between beads.

Wherever possible deposit in pads 1/2" to 1" wide, preferably not more than 3 inches long. Avoid long, narrow beads.

Allow to cool somewhat between beads.



Dragline bucket lip reclaimed by building up with "Manganweld B."

Precaution should be taken to avoid localized heating of manganese steel castings. Beads should be so placed that the heat is well distributed. If necessary, the work (not the weld) should be cooled with water periodically to prevent distortion and possible cracking of the casting. Hammer surface of bead immediately while cooling, to compensate for shrinkage.

Clean off all slag and brush area where next bead is to be deposited.

Should not be quenched. It will form a tough deposit when allowed to cool naturally.

Not generally recommended for vertical or overhead welding. However, if such work is attempted, use lower current settings given for flat work.

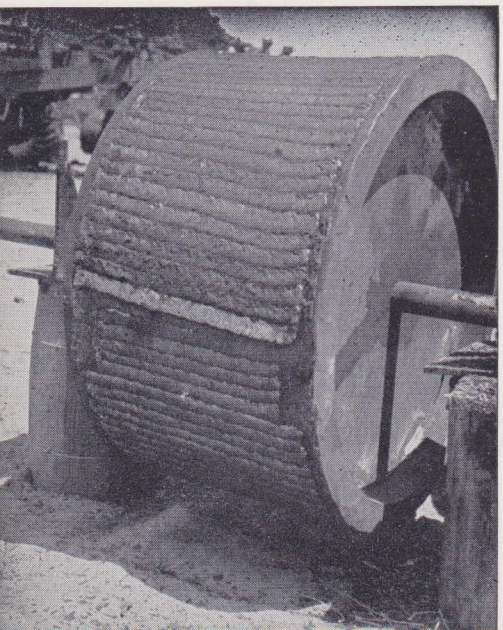
POSITION: FLAT				
Manganweld A		Manganweld B & C		Amperage Range
Dia.	Lgth.	Dia.	Lgth.	
5/32"	14"	.....	.....	90–130
3/16"	14"	3/16"	18"	130–210
1/4"	14"	1/4"	18"	170–225
.....	.....	5/16"	18"	180–275

"Manganweld" is packed in standard Lincoln containers of 50 lbs. each.

"Manganweld B"—available in 3/16" and 5/16".

"Manganweld C"—available in 3/16" and 1/4".

Worn roll of a rock crusher built up with "Manganweld A" at substantial saving over replacement.



Beads deposited on high manganese steel. Left: with "Manganweld A." Right: with "Manganweld B."

TYPICAL APPLICATIONS

Rail cross overs
Rail frogs and switches
Dipper teeth
Dipper lips
Shovel drive sprockets
Shovel tracks
Crusher pads
Rolling mill parts
Crusher hammers
Chain hooks
Strip mill wobblers
Manganese buckets
Crusher rolls
Crusher screens
Dragline pins and links
Cement grinder rings
Dredge parts

TUNGWELD C
TUNGWELD F

For Hard Surfacing to Resist Extremely Severe Abrasion

Coating—Dark Tan
Code—(none)

Coating—Gray
Code—(none)

APPLICATION

"Tungweld C" is a lightly coated tubular electrode containing *coarse* particles of tungsten carbide*, used for surfacing earth cutting tools when a jagged, rough, self-sharpening edge is required, and for facing surfaces to resist extremely severe abrasion.

PROPERTIES

"Tungweld C" deposits are studded with diamond-like granules of tungsten carbide held in a relatively tough alloy matrix. Tungsten carbide deposits are recognized to be the ultimate in resistance to abrasion. To date there is no commercial material, other than tungsten carbide which will produce weld deposits as resistant to abrasion or as satisfactory for earth cutting tools.

When the edge of the deposit is subjected to abrasive wear the iron alloy and the base metal wear away, exposing the tooth-like particles of tungsten carbide yielding a self-sharpening edge. This property is desired for earth digging or scraping tools.

PROCEDURE

POLARITY—"Tungweld C" D.C. electrode negative.

Weave beads ¾" to 1" for best results. Avoid excessively high current and puddling, which will result in the solution of more of the tungsten carbide forming a deposit less resistant to abrasion.

"TUNGWELD C"		
Tube Size		Amperage Range
Dia.	Length	
1/4"	14"	95–170‡

‡Use only enough current to get proper bonding to the base metal.

Worn dipper teeth built up with "Tungweld C." Beads run crosswise.

*Tungsten carbide used in "Tungweld" is a cast alloy of tungsten and carbon. The carbon content and the casting procedure are controlled to produce a weldable material having the maximum hardness and toughness required to yield the super abrasion resisting and fast cutting "Tungwelds."

ELECTRODE TO DEPOSIT 1 CU. IN.

"Tungweld C".....0.52 Lb.

"Tungweld F"..... .52 Lb.

If it is necessary to grind "Tungweld" deposits, silicon carbide grinding wheels are recommended.

Standard containers for both C and F: 5 lbs.

APPLICATION

"Tungweld F" is a shielded arc tubular electrode containing *fine* particles of tungsten carbide*, used for surfacing earth cutting tools when a smooth, thin, self-sharpening edge is required and for facing surfaces to resist extremely severe abrasion.

PROPERTIES

"Tungweld F" deposits contain fine particles of tungsten carbide* held in an iron alloy binder (matrix). The deposit has self-sharpening properties but the tungsten carbide particles are so small they will not stick out like teeth as in the case of edges surfaced with "Tungweld C". The tungsten carbide particles in "Tungweld F" are small enough and near enough together so that they are not undermined when exposed to a jet of sandy mud. "Tungweld F" is used for surfacing earth cutting tools when it is desired to have a thin deposit and also one that will wear to a sharper and smoother edge than "Tungweld C" deposits.

PROCEDURE

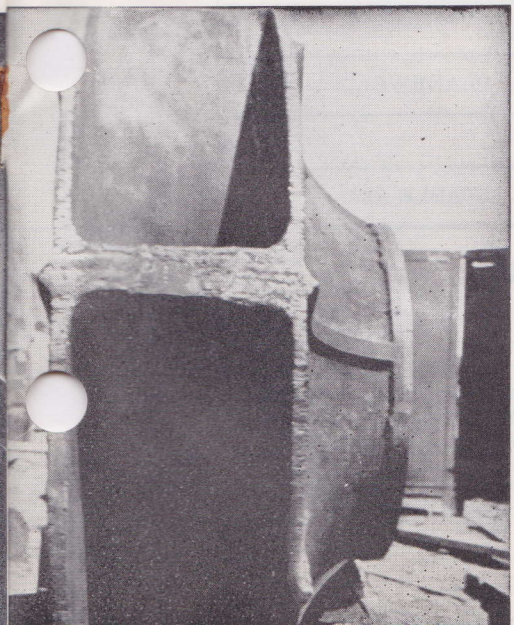
POLARITY—"Tungweld F" D.C. electrode positive, or A.C. (use with industrial type A.C. welders only).

Weave beads full width of the deposit if possible. One layer deposits recommended.

"TUNGWELD F"		
Tube Size		Amperage Range
Dia.	Length	
1/4"	14"	85–140

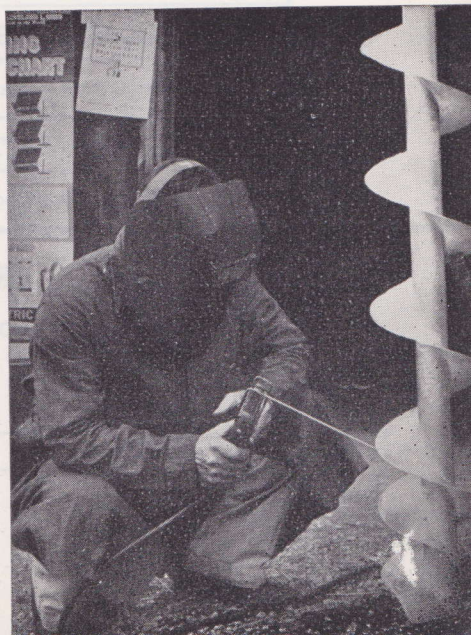
"Tungweld F" will be applied to edge of this post hole auger to make a smooth, thin, self-sharpening edge.

Gouged-out surfaces of dredge pump impeller were built up with "Fleetweld 5" and hardfaced with "Tungweld F."



TYPICAL APPLICATIONS

TUNGWELD C	TUNGWELD F
Oil well drilling bits (soft formation rotary type)	Dredge cutter blades
Ditch digger teeth	Cane knives
Scraper blades	Mixing blades
Tool joints (O. D.)	Coal cutter bits
Scarifier teeth	Tool joints (O. D.)
Dipper teeth	Post hole augers
Blast hole drilling bits	Pug mill augers
Muller plows	Pug mill knives

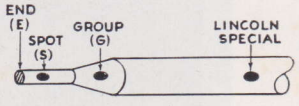


Guide for Selecting
MILD and LOW-ALLOY STEEL ELECTRODES
as listed in Weldirectory SB-1351

SPECIFIC TYPE OF WORK AND PROPERTIES	THE ELECTRODE
MILD STEEL WITH HEAVY COATED ELECTRODES	
All positions. D.C. Deep penetration. Flat shaped bead. Minimum slag.	FLEETWELD 5
All positions. D.C. Specially for root passes in pipe welding.	FLEETWELD 5-P
All positions. A.C. or D.C.	FLEETWELD 35
All positions. A.C. or D.C. For easy operation. Minimum slag.	FLEETWELD 180
All positions. D.C. or A.C. For poor fit-up. Convex bead.	FLEETWELD 7
Single pass, horizontal flat fillet, production welds. A.C. or D.C.	FLEETWELD 72
Extra fast welding for flat and horizontal fillets with A.C. or D.C.	JETWELD 1
All positions, especially vertically down. Thin plate. A.C. or D.C.	FLEETWELD 37
All positions. Easy operation and slag removal. A.C. or D.C.	FLEETWELD 47
All positions. A.C. or D.C. Iron Powder. Extra fast.	*"Improved"* FLEETWELD 47
Extra fast welding of flat, deep groove welds and horizontal fillets with A.C. or D.C.	JETWELD 2
SHEET STEEL	
All positions. Edge and corner welds. 16 to 22 gauge sheet. D.C. Flat bead.	LIGHTWELD
All positions. For poor fit-up. D.C. or A.C.	PLANEWELD
Brazing sheet metal with carbon arc or A.C. arch torch.	FLEETBRAZE
MILD STEEL, LOW-ALLOY HIGH-TENSILE STEEL, HARD-TO-WELD STEELS	
General purpose, low hydrogen electrode specially suited for steels of poor weldability.	SHIELD-ARC LH-70
LOW-ALLOY HI-TENSILE STEEL	
All positions. High strength. D.C.	SHIELD-ARC 85
All positions. High strength. D.C. For pipe welding.	SHIELD-ARC 85-P
For extra fast welding of flat position, deep groove joints. Fillets. High strength. D.C. or A.C.	JETWELD 2-HT
All positions. Exceptionally high ultimate strength. D.C.	SHIELD-ARC 90 CM
CHROME-MOLY STEEL, HIGH STRENGTH FERRITIC STEELS	
Airplane Parts, .120" thickness up. Similar to SAE 4130 and X4130	PLANEWELD 1
MILD STEEL WITH LIGHT COATED ELECTRODES	
Washed electrode for all positions. D.C.	STABLE-ARC

KEY TO ELECTRODE IDENTIFICATION

by Code Colors



by A. W. S. Classes

The American Welding Society has established specifications for different type electrodes. The class listed for each electrode is the one under which that electrode is qualified. Although an electrode may meet the requirements of more than one class, it may only be listed under one.

A.W.S. has not established classes to cover all types of electrodes. Some electrodes (viz. the hard surfacing rods) have no classes listed.